Final Report

SHOEBURYNESS SEA DEFENCE APPRAISAL AND FLOOD RISK ASSESSMENT 2014

Prepared for

April 2014

GB

SECTION 2

2 Condition Survey and Options Assessment

2.1 Condition Survey

2.1.1 Introduction

A walk-over seawall condition assessment survey was undertaken by Halcrow-CH2r between Monday 20th January and Friday 24th January 2014. For the duration of the survey winds were light and the weather was generally fair. The vegetation to the landward and seaward faces of the sea walls was mostly uncut and generally heavy at the time of the survey making a detailed inspection and condition assessment of the crest and upper portions of the defence very difficult. The survey was timed to make the most of the morning low tide and generally began at first light on each day. Low water tide times during the week were as follows:

Monday 20th January	LW	08.55
Tuesday 21st January	LW	09.25
Wednesday 22nd January	LW	09.50
Thursday 23rd January	LW	10.20
Friday 24th January	LW	11.00

The defences were surveyed in the following order, largely dictated by the location and timing of the various range activities during the week:

Mon 20th January:

Shoeburyness - Southern boundary fence at The Boom, to Havengore Bridge (approx. 3.2 miles/5.1km), then Foulness Island North (part) - Shelford Creek (northside) to AWE opposite Potton Point (approx. 1.9 miles/3.1km).

Tues 21st January:

Foulness Island North (part) - The Quay to Foulness Point, then The Quay to AWE (approx. 7.0 miles/11.3km).

Weds 22nd January:

Potton Island (approx. 5.8 miles/9.3km).

Thurs 23rd January:

Foulness Island (Havengore & New England) - Shelford Creek (southside) to Havengore bridge, then beyond to Sharpsness Head (approx. 5.2 miles/8.4km).

Fri 24th January:

Foulness Island South - Sharpsness Head to Foulness Point (approx. 5.6 miles/9.0km).

A GPS camera was used during the survey to record the condition of the defences and other salient features. The GPS EXIF data from the photographs was then inspected using Picassa software and, after some minor location corrections, the locations were exported and plotted on Google Earth and saved as KMZ files. Chainages were determined using GIS software following the centreline of the seawalls, and mapped (Figures 2.1.1 – 2.1.3). The photo locations were subsequently matched to chainages.

Shoeburyness – Chainage 0m at The Boom ending at chainage 5225m at Havengore Bridge.

Foulness Island – Chainage 0m at The Quay, continuing clockwise around Foulness, Havengore and New England, returning to The Quay at chainage 31825m.

Potton Island – Chainage 0m at the north side of the Swing Bridge, continuing clockwise around the island, returning to the south side of the Swing Bridge at chainage 9175m.

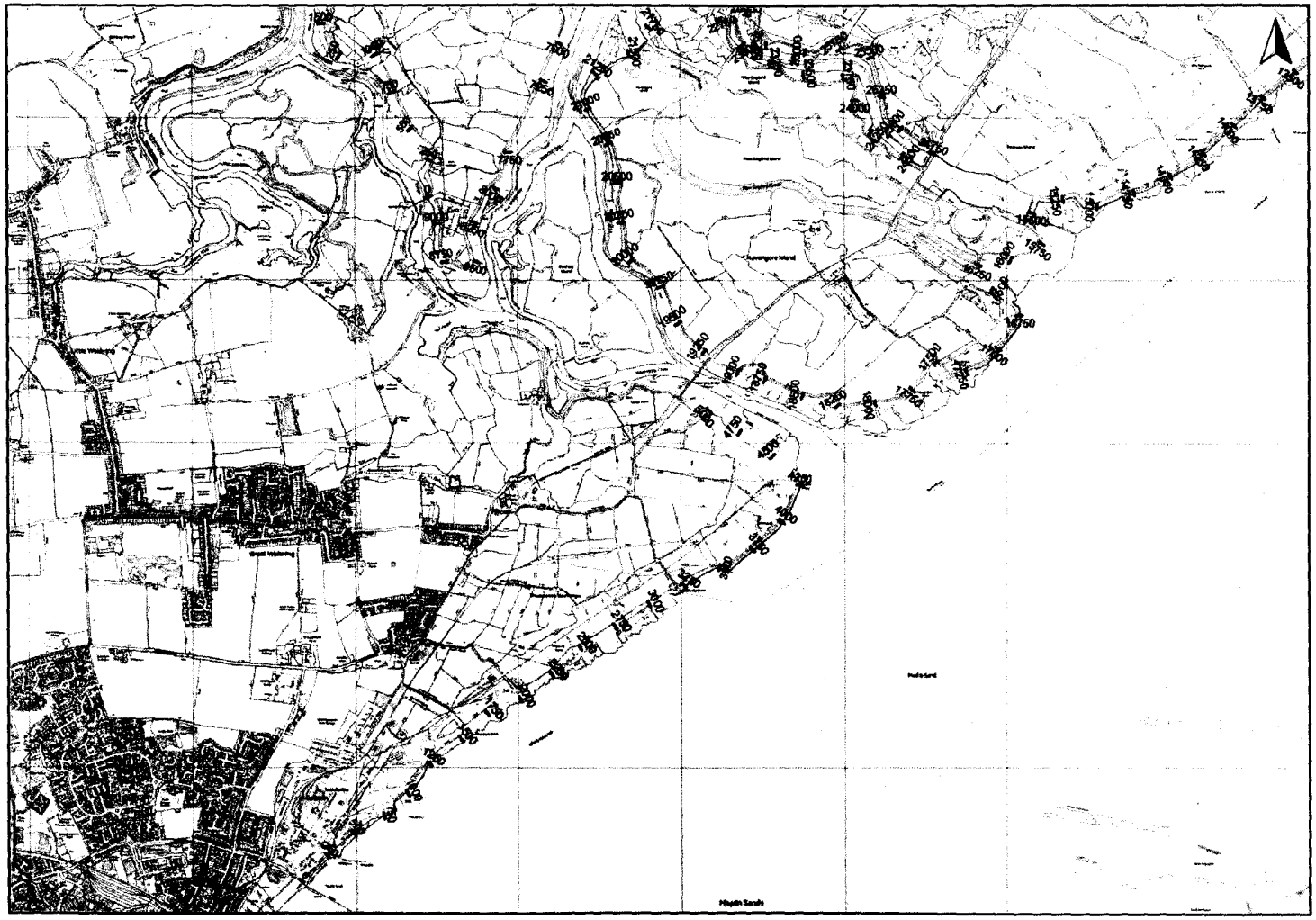


Figure 2.1.1 – Chainages (1 of 3)

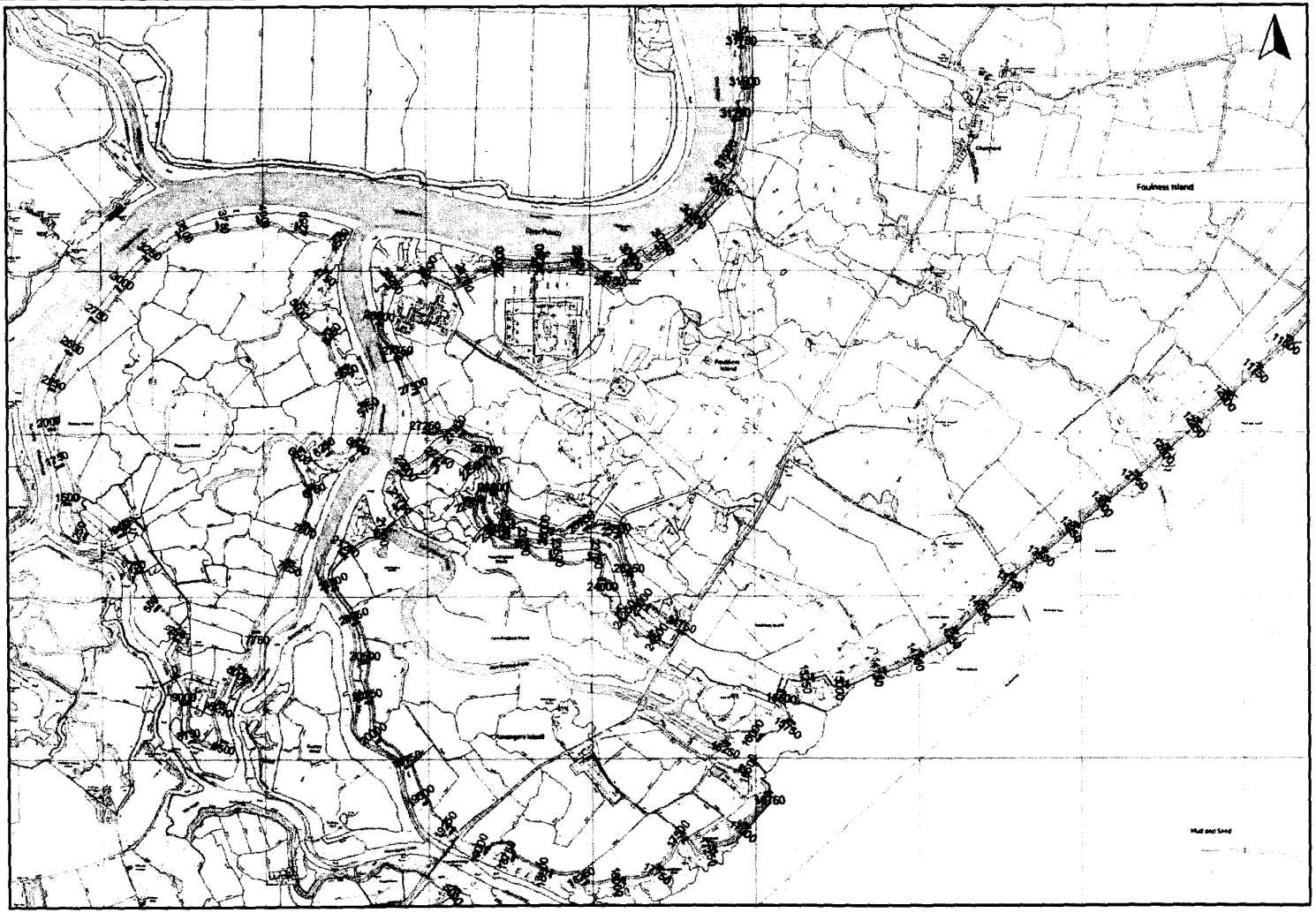


Figure 2.1.2 – Chainages (2 of 3)

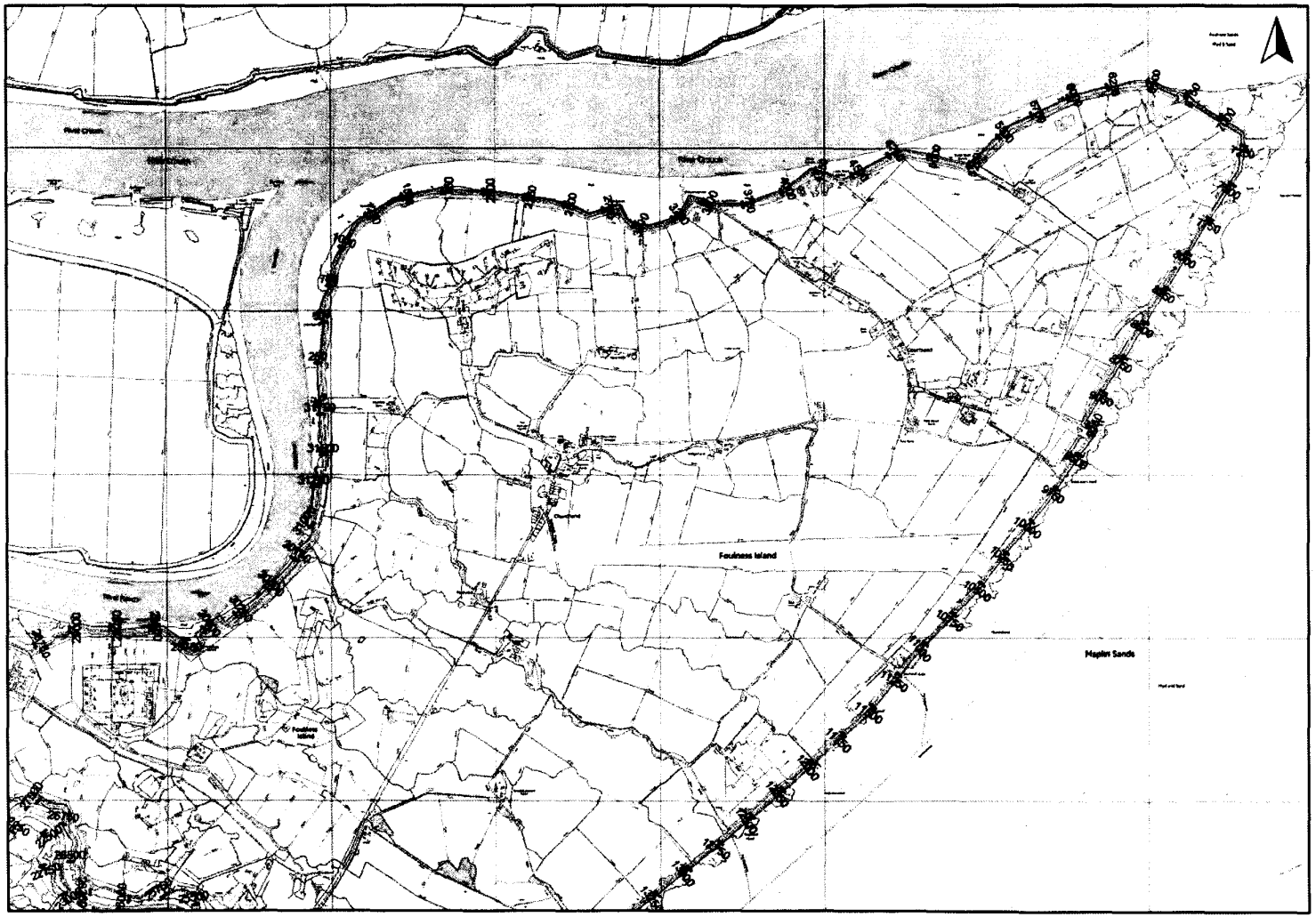


Figure 2.1.3 – Chainages (3 of 3)

The condition assessment descriptions that follow make reference to the chainages and photograph locations, hence may be read in conjunction with the associated Google Earth KMZ files, TatukGIS files, and survey photographs contained on the accompanying DVD. The QinetiQ building numbering system has also been referenced where relevant.

Figures 2.1.4 below shows typical Google Earth KMZ output. All KMZ files are contained in the Figures 2.1.5 and 2.1.6 show sample screenshots of the survey output contained on the TatukGIS database. Full coverage mapping of the site showing survey data and photo locations, extracted from the full TatukGIS database, is included in Appendix A. The full TatukGIS database is included in the

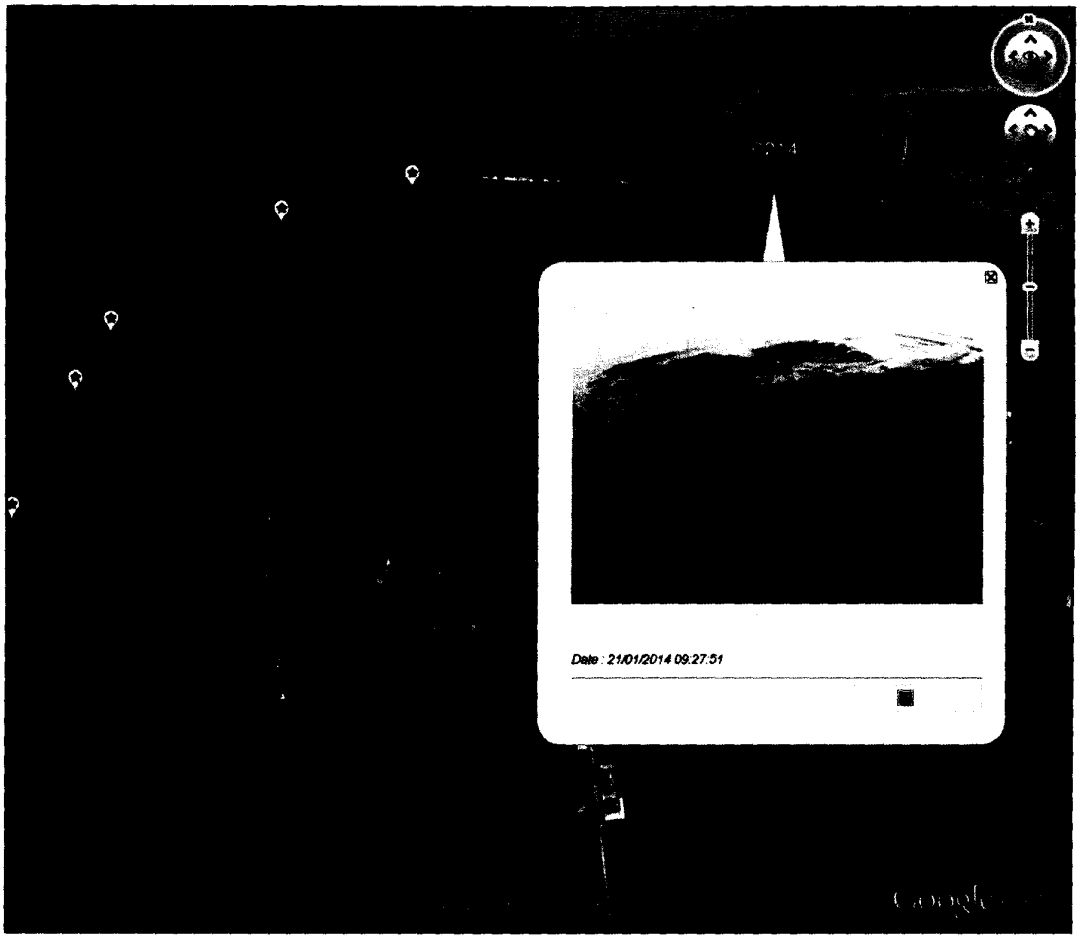


Figure 2.1.4 – Sample Google Earth KMZ file output

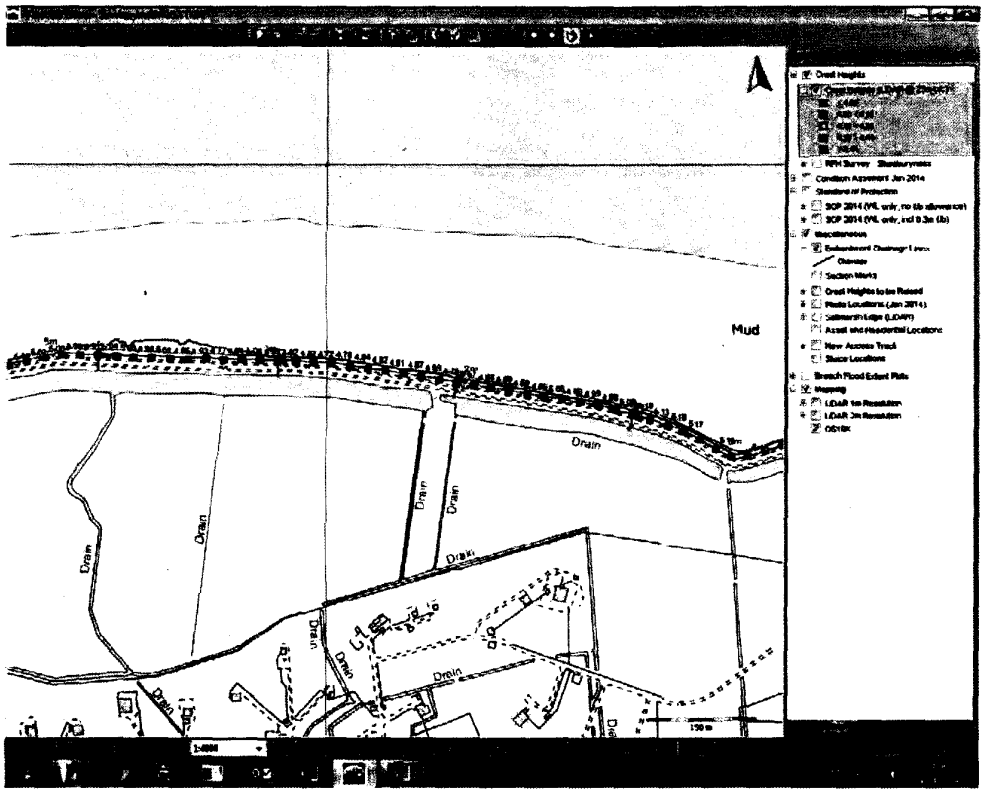


Figure 2.1.5 – Sample TatukGIS database output (1 of 2)

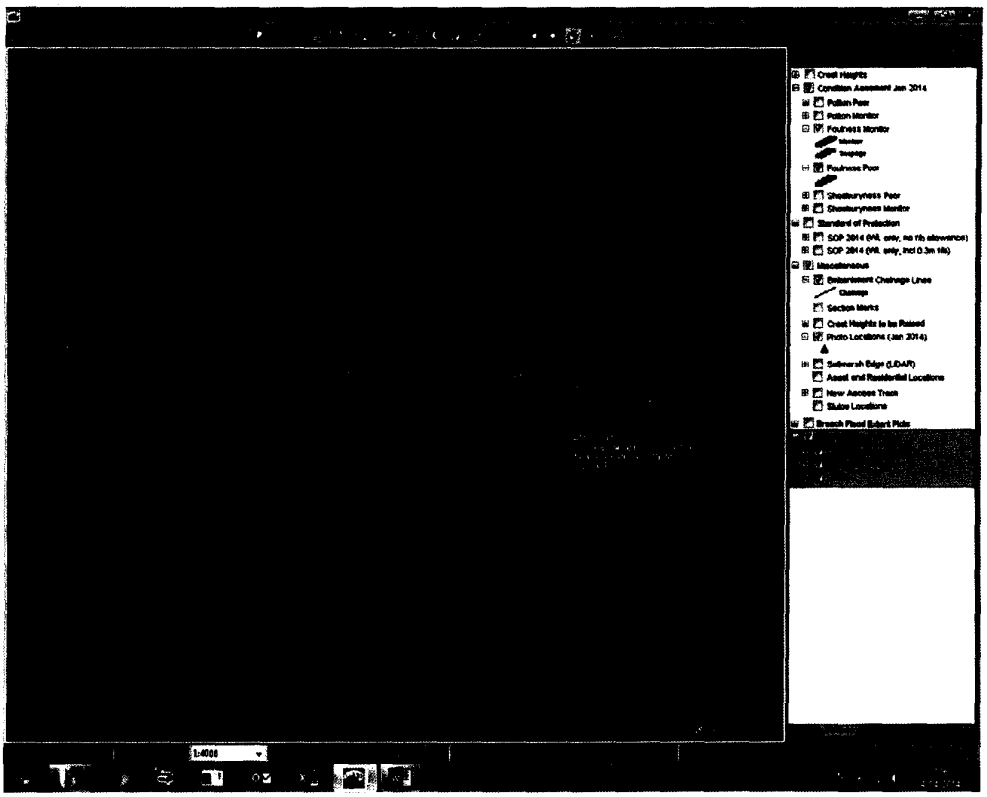


Figure 2.1.6 – Sample TatukGIS database output (2 of 2)

Although some obvious low spots in the defence were noted during the condition survey, the assessment of standard of protection (as related to crest height) was subject separate assessment and reporting (see section 2.2).

The condition assessment below categorises defences using the Environment Agency's 2011 Condition Assessment Manual classifications of VERY GOOD, GOOD, FAIR, POOR and VERY POOR – as defined below. Areas where the current condition suggests close monitoring is appropriate are also identified in the text.

Grade	Rating	Description
1	Very Good	Cosmetic defects that will have no effect on performance
2	Good	Minor defects that will not reduce the overall performance of the asset
3	Fair	Defects that could reduce performance of the asset
4	Poor	Defects that would significantly reduce the performance of the asset. Further investigation needed
5	Very Poor	Severe defects resulting in complete performance failure

Figure 2.1.7 – Extract from Environment Agency Condition Assessment Manual, 2011

It should be noted that where the defence condition could not be confirmed because of excessive vegetation, a condition assessment of FAIR was recorded ('Defects that could reduce the performance of the asset'). This condition cannot be confirmed until the vegetation is cut and the defences inspected for defects such as cracking and vermin infestation to the earth faces, and displacement and deformation of concrete blocks and slabs on the upper face.

All photographs referenced below are contained in the DVD. The photographs of defences classified as POOR are also in Appendix A.

2.1.2 Shoeburyness

Photo Ref	Chainage (m)	Condition Assessment
P066-P071	0 – 288 Fronting G7 & G36	FAIR. The sea defences comprise a concrete blockwork sea wall fronted by low dunes and a relatively healthy beach. Some of the blockwork needs attention (repointing) but appears generally sound.
P071-P075	288 – 540	FAIR. The sea defences comprise a concrete blockwork sea wall fronted by a grassed attention (repointing) but appears generally sound.
P076	540 Adjacent to J21	POOR. The seawall juts out onto the foreshore at this location and the base of the wall is more exposed. Although some anti-scour rock has been placed here in the past, it is not providing adequate protection and further erosion of the foreshore could risk undermining the wall foundations. Some of the wall blockwork needs attention (repointing) but appears generally sound.
P076-P086	540 - 925	FAIR to POOR – to be monitored. Base of seawall exposed. The seawall has generally been protected with rock and/or concrete rubble, but the protection is not continuous and may not be sufficient to ensure the wall stability in the longer term. The section should be monitored for signs of significant deterioration and improvement of the rock protection between from ch715-885m should be planned for the medium term. After the wall turns a right angle towards J Battery, there is a short section in the corner (P086) where the rock protection is more extensive and the condition here may be classified as FAIR.

Photo Ref	Chainage (m)	Condition Assessment
		Some of the wall blockwork needs attention (repointing) but appears generally sound.
P083	850	POOR. There is a gap evident between the timber flood boards and the adjacent concrete wall just beyond where the wall turns a right angle towards J Battery. If the boards are to be retained, they should be securely tied into the adjacent flood wall. If the boards are not required, they should be replaced with a flood wall.
P086-P089	925 - 1025 Fronting J Battery	FAIR. The wall is protected by Essex blocks and a narrow area of dune and beach. Some of the wall blockwork needs attention (e.g. repointing of cope blocks) but overall, where fronted by beach, it appears generally sound. Towards the northern end of the length (P089), the wall juts out onto the foreshore with rock protection at the base. This section appears sound but should be monitored for any future signs of significant deterioration or foreshore lowering, especially in the corner visible in P090, where additional rock protection should be added in the medium term.
P089-P094	1025 - 1215	FAIR. The wall is protected by an Essex block and concrete panel revetment with rock at the toe towards the northern end where foreshore levels are lower. The wall crest should be thoroughly checked to ensure the cope blocks are secure, but otherwise the defence appears sound.
P094-P100	1215 - 1550	At the time of the survey, this section was being re-constructed with gabion mattress protection and bank raising. The flood bank has been re-profiled in advance of receiving this protection and will be susceptible to erosion (hence strictly classified as POOR and should be monitored) until the protection is in place.
P100-P105	1550 - 1920	FAIR. The flood bank steps back landward and is fronted by saltmarsh. The bank is very overgrown and hence the condition of the crest and any Essex block protection present was not determined with certainty.
P106-P107	1920 - 2120	FAIR. The flood protection is formed from a raised reclaimed area formed from soil and rubble that extends out onto the foreshore. Although the front face is clearly subject to some erosion, the erosion appears gradual and the raised profile suggests that this section is not an immediate concern. However, it should be considered for protection in the longer term.
P108-P109	2120 -2245	FAIR. The flood embankment is protected by a relatively recent concrete panel revetment, the toe of which appears well buried in the sandy foreshore, with some rock protection.
P110	2245 -2275	FAIR. The embankment here is protected by a rock armour revetment. However, the rock only extents part way up the face of the bank and appears to have been placed directly onto the bank with no underlayer rock or geotextile. The bank is therefore susceptible to erosion here and should be monitored, with a view to improving the rock protection in the medium term.
P111-P112	2275 - 2500	FAIR. The flood bank turns slightly landward and appears to have been constructed as a replacement defence for an older bank in front, the remnants of which are still visible. The bank is fronted by saltmarsh

Photo Ref	Chainage (m)	Condition Assessment
		and very overgrown, hence the condition of the crest and any Essex block protection present was not determined with certainty.
P113-P117	2500 - 3100	FAIR. The bank is protected with a concrete panel revetment and fronted by relatively wide saltmarsh. The top of the concrete panels is somewhat higher than the crest of the bank. The sealant between adjacent panels has degraded and become vegetated in places.
P117-P122	3100 – 3320	FAIR. There is no saltmarsh along this section and bank here is protected with a concrete panel revetment with rock protection at the toe. The top of the revetment is heavily vegetated in places.
P123-P126	3220 – 3475	FAIR. The bank is protected with Essex blocks (upper face) and a concrete panel revetment. A concrete walkway protects the crest. The revetment face is overgrown in places, particularly where the Essex blocks are present at the upper face, indicating loss of bonding between the blocks. A narrow sandy foreshore is present along the southern part of the section. Along the northern part, there is rock protection at the toe.
P126	3475	FAIR. Although the condition is fair, seaweed on the crest indicates that the bank here was overtopped during the Dec 2013 storm surge event. The crest appears to be similar in level to adjacent sections, so the overtopping may have been caused by currents and wave action raising the water level locally at this corner location. The rear bank is unprotected all along this section, so prolonged overtopping could weaken the bank and significantly increase the risk of failure.
P126-P130	3475 – 3760	FAIR. The bank is protected with Essex blocks (upper face) and a concrete panel revetment. A concrete walkway protects the crest. The revetment face is overgrown in places, particularly where the Essex blocks are present at the upper face, indicating loss of bonding between the blocks. There is rock protection at the toe and a short section where the toe has been further reinforced with a concrete apron (P127). The concrete crest walkway ends at ch3760m (P130).
P130-135	3760 – 4250	FAIR. The bank is protected with Essex blocks and a concrete panel revetment. The revetment face is overgrown in places, particularly where the Essex blocks are present, indicating possible loss of bonding between the blocks. There is rock protection at the toe. A localised concrete patch repair is located at the crest of the defence.
P135-P136	4250 – 4275 Q Battery	FAIR. Around the headland, bank protection is provided by concrete panels with rock armouring at the toe.
P138 - P139	4275 – 4400	FAIR. As the bank turns towards Havengore Bridge, it is protected by a concrete panel revetment and is fronted by a widening of saltmarsh. The crest is overgrown, impeding easy access, and the crest level appears noticeably lower than the preceding section.
P139-P144 and P810-812	4400 – 5225 Havengore Bridge	FAIR. The bank is very overgrown, hence the condition of the crest and any face protection was not determined with certainty, but it is fronted by a wide area of saltmarsh. Sluice #15 is at ch5050m

2.1.3 Foulness Island

Photo Ref	Chainage (m)	Condition Assessment
P180-P181	0 - 220	FAIR. The bank is protected by concrete panels to the lower face, Essex blocks on the upper face, and small size rock protection at the toe. The Essex blocks, crest and rear face are very overgrown. The vegetation on the Essex blocks may be reducing their interlock and weakening the defence.
P181	220	Sluice #6
P181-P187	220 - 641	FAIR. The bank is protected by concrete panels to the lower face, Essex blocks on the upper face, and small size rock protection at the toe. The rock is of small size and patchy, but there are no signs of serious toe erosion. The Essex blocks, crest and rear face are very overgrown. The vegetation on the Essex blocks may be reducing their interlock and weakening the defence.
P188	640	POOR. There is a significant lowering of the crest and upper face of the bank over approximately a 5m length close to Sluice #7. This needs to be repaired as a priority to maintain the integrity of the defence.
P189-P191	640 - 1109	FAIR. The bank is protected by Essex blocks on the front face, and is fronted by a relatively healthy length of saltmarsh. The Essex blocks are very overgrown, as are the crest and rear face.
P192-P193	1109 - 1161	POOR. The bank is protected by Essex blocks and concrete panels on the front face, and scattered rock protection at the toe. The rock toe protection has degraded and is scattered. The toe is exposed and requires a priority repair and improvement between the end of the saltmarsh and the start of the larger toe rock protection along the following section (ch1161m). The improvement works should tie well into the saltmarsh to prevent erosion and outflanking at the transition and could be similar in nature to those shown on P193. The Essex blocks over this section are very overgrown, as are the crest and rear face.
P193-P197	1161 - 1610	FAIR. The bank is protected by Essex blocks and concrete panels on the front face, and well graded, larger size armour rock on the toe. The upper face, crest and rear face of the bank are overgrown.
P197-P198	1610 - 1735	FAIR to POOR. The bank is protected by Essex blocks and concrete panels on the front face. The rock toe protection has degraded and is scattered. The Essex blocks over this section are very overgrown, as are the crest and rear face. Towards the east end of this section the rock protection is largely absent and the toe is starting to become exposed. There are signs that the Essex blocks at the toe are starting to deform. This section should be monitored and improvement works planned for the short-medium term. It may be prudent to extend the more urgent improvement works described in the next section over this length as well.
P198-P209	1735 - 1919	POOR. The bank is protected by Essex blocks and concrete panels on the front face. The rock toe protection has degraded and is scattered. The Essex blocks over this section are very overgrown, as are the crest and rear face. The toe beam is exposed and liable to fail over approximately a 150m length. Repair and improvement works should be undertaken over this length as a priority to ensure to the integrity of the defence. Replacement of the toe support structure is likely required.
P209-P210	1919 - 2040	POOR. The bank is protected by Essex blocks and concrete panels on the front face. The rock toe protection has degraded and is scattered.

Photo Ref	Chainage (m)	Condition Assessment
		The Essex blocks over this section are very overgrown, as are the crest and rear face. The toe beam is becoming exposed and will be liable to fail over approximately a 125m length. Although not in quite as poor condition as the preceding section, it would be prudent to undertake a close inspection of the integrity of the toe structure and plan for similar repair and improvement works over this length as a priority.
P210-P215	2040 - 2124	POOR. The bank is protected by Essex blocks and concrete panels on the front face. The rock toe protection has degraded and is scattered. The Essex blocks over this section are very overgrown, as are the crest and rear face. The toe beam is becoming exposed and the concrete apron immediately behind is fragmenting over approximately a 300m length. The integrity of the toe should be closely examined and a decision made as to whether a replacement toe is required in addition to repair of the concrete apron. Again, it would be prudent to undertake repair and improvement works over this length as a priority to ensure to the future integrity of the defence.
P215-P217	2124 - 2232	FAIR. The bank is protected by concrete panels on the front face. The rock toe protection has degraded and is scattered. The concrete panels over this section are very overgrown, as are the crest and rear face. The front panels require some patch repair. The toe of the structure is currently buried in the foreshore and the lack of any obvious deformation of the face suggests it may still be sound. However, given the condition of the adjacent section it would be prudent to monitor this section closely, investigate the condition of the toe structure, and plan for improvement works including toe protection in the short to medium term.
P217-P223	2232 - 2503	POOR. The bank is protected by concrete on the front face. The rock toe protection has degraded and is scattered. The front face is overgrown, as are the crest and rear face. The front panels have deteriorated exposing the underlying stone pitching and clay bank in some locations, necessitating a more urgent repair and improvement. The condition of the toe structure should also be investigated and improvement works to the toe also planned for the short-medium term.
P223-P226	2503 - 2674	FAIR. The bank is protected by concrete panels on the front face. The rock toe protection has degraded and is scattered. The crest and rear face are overgrown. The front face panels are showing signs of gradual deterioration towards the toe, and the frontage should be monitored and repair and/or improvement works planned for the medium to longer term.
P226-P230	2674 - 2921	FAIR. The bank is protected by concrete panels on the front face, and small size rock on the toe. The crest and rear face are overgrown except where cutting has taken place over the ongoing repair works section described below. Note benefits of grass cutting evident on P229.
P230-P234	2921 - 3207	FAIR. The bank is protected by concrete panels on the front face, and small size rock on the toe. At the time of the survey, the defence was being investigated for UXBs in advance of planned reconstruction works to replace the toe. The investigation has caused erosion of the crest which should be reinstated at the first opportunity. The section contains a short length where the concrete face panels have disintegrated exposing the stone pitching beneath – see below.

Photo Ref	Chainage (m)	Condition Assessment
P233	3177	POOR. Priority repair required to a short (approx. 15m length) of concrete face panels where the stone pitching beneath has become exposed.
P234-P236	3207 - 3364	FAIR. The bank is protected by concrete panels on the front face, and small size rock on the toe. The crest and rear face are slightly overgrown. The toe was buried in the foreshore at the time of the survey, but the general condition of the defence suggests that it is sound. Sluice #8 at P236.
P237-P239	3364 - 3518	FAIR. The bank is protected by more recent concrete panels on the front face, and scattered, small size rock on the toe. The crest and rear face are overgrown. The toe was buried in the foreshore at the time of the survey, but the general condition of the defence suggests that it is sound. The lack of comprehensive toe protection should be addressed in the medium-longer term.
P239-P244	3518 - 3974	FAIR. The bank is protected by relatively recent concrete panels on the lower front face, Essex blocks to the upper face, and a narrow portion of small size rock on the toe. The Essex blocks, crest and rear face are overgrown. The toe was buried in the foreshore at the time of the survey, but the general condition of the defence suggests that it is sound. The lack of comprehensive toe protection should be addressed in the medium-longer term. Sluice #9 at P244.
P244-P247	3974 - 4219	FAIR. The bank is protected by relatively recent concrete panels on the lower front face, Essex blocks and further, older concrete panels to the upper face. There is some small size rock protection on the toe. The Essex blocks, crest and rear face are heavily overgrown with grass and shrubs which are compromising the integrity of the upper portions of the defence.
P248-P249	4219 - 4222	POOR. Priority repair required to a short (approx. 5m length) of deteriorated concrete lower face panels, where the stone pitching beneath has become exposed.
P250-P251	4222 - 4451	FAIR. The bank is protected by concrete panels and Essex blocks on the upper front face, with more recent concrete apron works at the toe. The toe structure itself is well buried by a localised build-up of shell fragments and shingle with some vegetation. The Essex blocks, panels, crest and rear face are heavily overgrown with grass and shrubs.
P251-P255	4451 - 4648	FAIR. The bank is protected by concrete panels with some rock protection at the toe. The Essex blocks, panels, crest and rear face are heavily overgrown with grass and shrubs. Although vegetated in places, the front face and toe appear intact.
P255-P258	4648 - 4802	FAIR. The bank is protected by more recent concrete panels with rock protection at the toe. The crest and rear face are overgrown.
P258-P261	4802 - 5088	FAIR. The bank is protected by older concrete panels to the upper face, more recent panels towards the base, and with some rock protection at the toe. The crest and rear face are overgrown. Although vegetated in places, the front face and toe appear intact.
P261-P264	5088 - 5234	FAIR. The bank is protected by older concrete panels to the upper face, more recent panels towards the base, and with recent and extensive rock protection at the toe. The crest and rear face are overgrown. There is a concrete crest slab present towards the east end of the section.
P264-P280	5234 - 6186	FAIR. The bank face is protected by more recent concrete panels, with older Essex blocks to the upper face, and a concrete crest slab. There is small sized rock protection at the toe which becomes progressively

Photo Ref	Chainage (m)	Condition Assessment
		more deeply buried towards the eastern end of the section. The crest, upper face and rear face are very heavily overgrown with grass and shrubs, potentially weakening the upper portion of this section.
P280-P286	6186 - 6632	FAIR. The bank face is protected by more recent and substantial concrete panels and a concrete crest slab. There is small sized rock protection at the toe which is largely buried. The crest and rear face are overgrown, and the crest slab has settled/rotated back towards the landward side.
P286-P294	6632 - 7150 Foulness Point	FAIR. The bank face is protected by concrete panels and a concrete crest slab. Fronting the bank is a substantial foreshore comprising shell fragments, with a wide expanse of healthy saltmarsh further towards the eastern end of the section. The crest and rear face are heavily overgrown, particularly towards the eastern end, where brambles and shrubs make the crest almost impassable.
P794	7150 - 9300	FAIR. Bank face is protected by concrete slabs and fronted by relatively wide, healthy saltmarsh. Bank crest, rear face and front face are very overgrown preventing visual inspection of their condition. Bank crest appears to be around 200-300mm below the top of the concrete panels suggesting some settlement of the bank has occurred since its construction.
P795	9297	Possible badger set entrance.
P786-P794	9300 - 9698 Northern Corner to Fisherman's	FAIR. The bank is protected by concrete crest and concrete face panels. Rock toe protection is present over a short length where the saltmarsh has eroded. Crest and rear face of bank is overgrown.
P774-P786	9698 - 10681	FAIR. The bank is protected by concrete crest, face panels and rock at the toe. Toe protection is omitted where saltmarsh present.
P772-P774	10681 - 10770	FAIR. Short length of saltmarsh fronting the bank. Rock toe protection absent.
P771-P772	10770 - 10780	FAIR. Low spot on bank crest creating a potential weak point. Monitor. Candidate for medium term improvement works to raise the crest level.
P770-P771	10780 - 11000	FAIR. The bank is protected by concrete panels which are heavily vegetated between their joints and rock at the toe.
P770	10822	Groyne formed from gabion baskets. Some accretion of beach either side, possibly indicating potential to hold a beach along this frontage
P762 - P765	11000	POOR. The crest slab and upper concrete panel are cracked and displaced over approximately a 5m long section. The Dec 2013 overtopping is likely to have weakened the defence at this location and the crest slab and upper panel should be repaired/replaced as a priority.
P760-P764	10822 - 11045	FAIR. The bank is protected by concrete crest, face panels and rock at the toe. The section should be monitored due to the apparently poor rock grading noted in other sections. Seaweed and other debris on the crest and down the rear face indicate that this section (ch10970-11045m) overtopped during the Dec 2013 surge event.
P750-P760	11045 - 11209 Eastwick Battery	FAIR. The bank is protected by concrete panels and rock at the toe. At Eastwick, the concrete walkway on the crest narrows and ramps up by about 1m. The toe protection along this section should be monitored since it appears to be poorly graded with a substantial portion of smaller rock present which appears to be mobile under wave action. As well as reducing the effectiveness of the toe protection, the mobile rocks could cause damage to the concrete panels.

Photo Ref	Chainage (m)	Condition Assessment
P741-P750	11209 - 11660	FAIR. The bank is protected by concrete panels and rock at the toe, and has a concrete walkway on the crest. The toe protection should be monitored since it appears to be poorly graded with a substantial portion of smaller rock present which appears to be mobile under wave action (see P744). As well as reducing the effectiveness of the toe protection, the mobile rocks could cause damage to the concrete panels.
P728-P740	11660 - 12224	FAIR. The bank is protected by concrete panels and Essex blocks and has a concrete walkway on the crest. The face and rear bank face are generally overgrown at the southern end, particularly around ch12225m where a short length of saltmarsh is present and toe protection is absent. The upper portion of the panels are more deteriorated over the southern part of this section than the northern part. For the majority of the section, the toe has rock protection in place. Sluice #11 at ch11990m.
P720-P728	12224 - 13062 Rugwood Battery	FAIR. The bank is protected by concrete panels and Essex blocks and has a concrete walkway on the crest. The panels, crest and rear bank face are overgrown in places. Where saltmarsh is absent, the toe has rock protection and also an extended concrete toe apron in places.
P716-P719	13062 - 13278	FAIR. The bank is protected by concrete panels and Essex blocks and has a concrete walkway on the crest. The panels, crest and rear bank face are overgrown in places. The toe has rock protection where the saltmarsh is absent.
P711-P716	13278 - 13801 X3 Battery	FAIR. The bank is fronted by relatively healthy saltmarsh. The bank is protected by concrete panels and has a concrete walkway on the crest. The panels, crest and rear bank face are overgrown in places.
P706-P710	13801 - 14813 Asplins Head to Shelford Head	FAIR. The bank is fronted by relatively healthy saltmarsh. The bank is protected by concrete panels. The panels, unprotected crest and rear bank face are heavily overgrown. The crest appears to be lower than the concrete slabs suggesting that the crest may have settled slightly after the construction of the slabs.
P698-P706	14813 - 16191	FAIR. The bank is fronted by a wide area of healthy saltmarsh. The bank is heavily overgrown so the condition or presence of any face protection including concrete panels was not determined with certainty. Sluice #12 at ch15725m.
P693-P698	16191 - 16372	FAIR. The bank is fronted by a wide area of healthy saltmarsh. The bank is very overgrown up to the point where the bank is replaced by the concrete dam wall at the New England battery.
P691-P694	16372 - 16642	FAIR. The bank is fronted by a wide area of healthy saltmarsh. The bank is very overgrown and seepage is evident on the landward side which should be monitored.
P688-P691	16642 - 16719	FAIR. The bank is protected with concrete panels, is fronted my widening saltmarsh and has a concrete crest. There is a concrete crest from ch16640m.
P685-P686	16840	POOR. The POOR rating refers to the condition of the concrete panels on the face which are badly cracked in places and in need of a priority repair with appropriate bitumen sealant or cementitious grout.
P680-P688	16719 - 17056	FAIR. The bank is protected by concrete walkway on the crest, concrete panels on the face, and rock at the toe. Sections of the concrete panels have been recently overlaid with asphalt which appears to be in good condition. The toe protection should be monitored since it appears to be poorly graded with a substantial portion of smaller rock present that may be moved by wave action over time.

Photo Ref	Chainage (m)	Condition Assessment
P676-P680	17056 - 17125	POOR. The POOR rating refers to the condition of the concrete panels on the face and on the crest which are badly cracked and in need of a priority repair with appropriate bitumen sealant or cementitious grout. Sections of the concrete panels have been recently overlaid with asphalt which appears to be in good condition. The toe protection should be monitored since it appears to be poorly graded with a substantial portion of smaller rock present that may be mobile under wave action. As well as reducing the effectiveness of the toe protection, the mobile rocks could damage the concrete panels.
P671-P676	17125 - 17256	FAIR. Where the saltmarsh is not present, the bank is protected by concrete walkway on the crest, concrete panels/Essex blocks, and rock at the toe. Sections of the concrete panels have been recently overlaid with asphalt which appears to be in good condition.
P667-P670	17256 - 17383	FAIR. The bank is fronted by less healthy saltmarsh and has a concrete walkway on the crest. The walkway is overgrown with brambles.
P662-P667	17383 - 17705	FAIR. The bank is fronted by a wide area of healthy saltmarsh. The bank is heavily overgrown so the condition or presence of any face protection was not ascertained. Sluice #13 at ch17650m.
P649-P661	17705 - 18876	FAIR. The bank is fronted by a wide area of healthy saltmarsh. The bank is heavily overgrown so the condition or presence of any face protection was not determined with certainty. Signs of seepage were evident along this whole section which should be monitored.
P649	18876	Possible badger set entrance.
P641-P648	18876 - 19215	FAIR. The bank is fronted by a wide area of healthy saltmarsh. The bank is heavily overgrown and seaward face is very steep so the condition or presence of any face protection was not ascertained. Havengore Bridge at ch19190m.
P639-P640	19215 - 19937	FAIR. The bank is fronted by a wide area of healthy saltmarsh and protected with some stone pitching.
P636-P637	19937 - 20092	FAIR. The bank is fronted by a wider area of saltmarsh and protected with some stone pitching.
P634-P635	20092 - 20165	FAIR. The bank is protected by a narrow strip of saltmarsh and concrete panels. The saltmarsh appears to be eroding slowly, but the bank condition is not an immediate concern.
P632-P633	20165 - 20402	FAIR. The bank is protected by a narrow strip of saltmarsh that appears to be eroding, although the erosion seems gradual and is not an immediate concern. A potential candidate for longer term improvement works.
P631-P632	20402	FAIR. Where the saltmarsh is not present at the corner, the bank is protected with more substantial stone work.
P629-P630	20402 - 20611	FAIR. The bank is protected by saltmarsh and has some stone/concrete protection.
P627-P628	20611 - 20673	FAIR. The stone protection at the toe is less substantial and showing signs of erosion so should be monitored. A candidate for medium to longer term works to extend the better stone works at the sluice to the saltmarsh.
P624-P627	20673 - 20739	FAIR. The section either side of sluice #14 (ch20666m) is relatively well protected with concrete panel works and stone at the toe. Signs of seepage on the landward side which should be monitored.
P620-P623	20739 - 21185	FAIR. Although the bank is protected with relatively recent concrete panel works, it should be monitored since the stone protection at the

Photo Ref	Chainage (m)	Condition Assessment
		toe is missing or inadequate in places and there are signs of seepage on the landward side.
P620	21185 - 21200	FAIR. There is a short section of quite badly eroded stone protection between the end of the saltmarsh and the start of the more recent concrete panel works. This section should be monitored and the protection improved in the medium term with stone or an extension of the panel works, to tie into the saltmarsh. Signs of seepage on the landward side.
P616-P619	21200 - 21556	FAIR. The bank is protected by saltmarsh, but there are signs of seepage all along the access track and this should be monitored.
P612-P616	21556 - 21717	FAIR. The bank is protected with larger stone at the corner which appears adequate. As the bank approaches the dam, the condition of the concrete/stone protection deteriorates at the toe and should be monitored, as should the bank on the immediate other side of the dam (P616).
P608-P611	21717 - 21992	FAIR. The bank is protected by saltmarsh, but is showing some grazing damage to the toe which is narrow in places.
P605-P607	21992 - 22014	FAIR. The stone protection is more exposed at the corner and appears more eroded than adjacent sections, hence should be monitored and should be a candidate for medium to longer term improvement works.
P603-P605	22014 - 22240	FAIR. The bank is protected by older concrete panels and stone pitching which is showing signs of gradual erosion at the base. Although this does not appear to be an immediate cause for concern, this section (ch22165-22240m) should be monitored and is a candidate for medium terms works to improve the protection and link up the two adjacent concrete panel revetments. Signs of seepage appear around ch2300m which should be monitored.
P601 & 603	22240 & 22304	POOR. See below.
P601-P603	22240 - 22304	FAIR. The concrete panels protecting the bank over this length are in a fair condition, however, there are voids forming beneath both end panels that require early repair. The repair should tie well into the bank/saltmarsh to avoid any discontinuity which will encourage erosion and outflanking. Signs of seepage are also present along this section which should be monitored.
P577-P584	22304 - 24650	FAIR. The bank along the south side of Shelford Creek has intermittent stone pitching protection and is fronted by saltmarsh that is narrow or non-existent in places. As the bank nears the spine road it is protected with concrete panels. The stone pitching is loose in places, but is not too severely degraded. The bank is generally overgrown, but less so than other sections around the site due to sheep grazing. The sheep grazing itself is causing the slow erosion of the front face which is approximately a 1 in 1 slope, crest and base of the bank where it is in danger of being undercut. For this reason the section should be monitored. There is also evidence of seepage along the whole length. There is one location where erosion of the bank is sufficiently severe to warrant early repair (P578 – see below).
P599-P601	22304 - 22554	FAIR. Saltmarsh is generally wider and healthier over this section, but there are significant signs of seepage, so the section should be monitored.
P595-P599	22554 - 22966	FAIR. Saltmarsh is intermittent over this section. The bank is protected with stone pitching showing signs of slow erosion and should be monitored with a view to being upgraded in the medium to longer

Photo Ref	Chainage (m)	Condition Assessment
		term. There are also signs of seepage along this section which should be monitored.
P588-P594	22966 - 23579	FAIR to POOR. Saltmarsh is intermittent over this section. The bank is protected with concrete panels at the headlands and stone pitching elsewhere. The protection is showing signs of slow erosion and should be monitored with a view to being upgraded in the medium to longer term. At ch23325m (P589) the defence consists of a heavily vegetated front slope which has been cut back to a very steep angle with random/displaced concrete blocks to the lower slope. This section, although not at immediate risk due to its sheltered nature, should be considered for repair in the medium to longer term. Signs of seepage which should be monitored.
P585-P588	23579 - 23825	FAIR. The bank has intermittent stone pitching protection and is fronted by saltmarsh that is generally wide and healthy but does narrow in places. The bank suffers from the erosive effects of sheep grazing at the base, although the issue is less severe than elsewhere. The defence is heavily vegetated. Signs of seepage continue along this section which should be monitored.
P584-P585	23825 - 23836	FAIR. At the more exposed point where the wall turns south, the bank is protected with concrete panels. The panels are eroded at their base, but the erosion appears slow. While this erosion is not an immediate cause for concern, this section should be monitored. The seaward face of the defence is very steep and heavily vegetated and should be monitored. Signs of seepage which should be monitored.
P578	24567	POOR. It appears that the bank has suffered a small slip failure over a short length (approx. 5m) at this location. Failure has reached the crest of the bank and this warrants a priority repair.
P146 & P147	**24650 - 24750**	Steel sheet pile headwall/dam at the head of Shelford Creek appears in good condition.
P146-P149	24750 - 25186	FAIR. The bank face is protected with concrete panels and stone pitching with saltmarsh in front. The crest, front and rear slope are overgrown making an assessment of the face condition difficult. There are two areas where the saltmarsh has eroded back close to the bank toe and these should be monitored with a view to improvement works being undertaken in the medium to longer term.
P149-P152	25816 - 25445	FAIR. The bank face is protected with concrete panels and stone pitching with a narrow strip of saltmarsh in front. The crest, front and rear slope are overgrown making an assessment of the face condition difficult. There are signs of seepage along this section which should be monitored.
P152-P155	25445 - 25733	FAIR. The bank face is protected with concrete panels and stone pitching with relatively wide saltmarsh in front. The crest, front and rear slope are overgrown making an assessment of the face condition difficult. There are signs of seepage along this section which should be monitored.
P155-P156	25733 - 25739	FAIR. The bank extends into the foreshore with no saltmarsh in front, and stone pitching and concrete to the base. The existing bank protection here appears adequate. Signs of seepage which should be monitored.
P156-P179	25739 - 27218 Just south of AWE	FAIR. The bank face is protected with concrete panels and stone pitching generally with relatively wide saltmarsh in front. The crest, front and rear slope are overgrown making an assessment of the face condition difficult. Where the saltmarsh narrows, or is not present, the

Photo Ref	Chainage (m)	Condition Assessment
		existing bank protection appears adequate although is clearly subject to gradual erosion. There are signs of seepage all along this section which should be monitored.
P359-P354	27721 - 28037 AWE	FAIR. The bank face is protected with concrete panels with protective saltmarsh in front. The condition of the upper panels is FAIR, however, the tide level was too high at the time of the survey to confirm the condition of the toe along this section. The section should be monitored and the toe condition inspected before determining the priority of any required works along this section. Sluice #1 at ch27750m. Some signs of seepage that should be monitored.
P344-P359	28037 - 29000	FAIR. The bank face is protected with concrete panels and Essex blocks with a relatively wide and healthy saltmarsh in front. The crest and rear slope are overgrown. Rock protection has been added around sluice #2 (ch29000m) near the end of this section. Some signs of seepage which needs to be monitored.
P337-P343	29063 - 29575	FAIR. The bank face is protected with concrete panels and Essex blocks with some patches of stone in front. The crest and rear slope are overgrown. The toe of the concrete panels is steadily deteriorating and there is very little or no protective saltmarsh in front. Although there is no immediate concern, this section should be monitored with a view for repair and/or improvement works to the lower panels and toe protection in the short-medium term. Sluice #3 at ch29540m.
P339 & P342	29113 and 29176	POOR. There are two locations within the preceding section where the face slabs have deteriorated to a degree sufficient to warrant more urgent, priority repair works.
P329-P337	29575 - 30077	FAIR. The bank face is protected with concrete panels and Essex blocks, with a relatively wide section of saltmarsh in front. The crest, front slope and rear slope are overgrown.
P325-P329	30077 - 30119	POOR. The bank extends into the foreshore at this location, saltmarsh is absent, and the lower portions of the concrete panel defence are deteriorating. Condition is variable and some areas have been improved with the provision of a concrete apron. These sections should be monitored, but some sections have deteriorated to a degree warranting priority improvement/repair works. See P326, 328 & 329.
P316-P324	30119 - 30604	FAIR. The bank face is protected with concrete panels and Essex blocks, with a relatively wide section of saltmarsh in front. The crest and rear slope, together with part of the front face are overgrown.
P316	30604	POOR. There is a localised section where the saltmarsh has eroded back to a point where the integrity of the toe structure may be in doubt. This requires further investigation to ascertain the condition of the toe structure, and either a repair or improvement works carried out as a priority. The works should include rock protection at the toe to prevent further erosion of the toe.
P312-P317	30604 - 30809	FAIR. The bank face is protected with concrete panels and Essex blocks, with a relatively wide section of saltmarsh in front. The crest and rear slope are overgrown.
P306-P313	30809 - 31156	FAIR. The bank face is protected with concrete panels, concrete toe apron and Essex blocks with some patches of stone in front. The crest and rear slope are overgrown. The toe of the concrete panels is steadily deteriorating and there is very little or no protective saltmarsh in front. Although there is no immediate concern, this section should be monitored with a view for repair and/or improvement works to the

Photo Ref	Chainage (m)	Condition Assessment
		lower panels and toe protection in the medium term. Sluice #4 at ch30900m (P310). Sluice #5 at ch30910m (P310).
P306	31156	POOR. The concrete panels and toe aprons have broken up at the toe to a degree sufficient to warrant a more urgent repair.
P302-P306	31156 - 31410	FAIR. The bank face is protected with concrete panels, concrete toe apron and Essex blocks with some patches of stone in front. The crest and rear slope are overgrown. The toe of the concrete panels is steadily deteriorating and there is very little or no protective saltmarsh in front. Although there is no immediate concern, this section should be monitored with a view for repair and/or improvement works to the lower panels and toe protection in the medium to longer term.
P302	31410	POOR. At the corner, the concrete panels have broken up at the toe to a degree sufficient to warrant a more urgent repair.
P295-P302	31410 - 31805	FAIR. The bank face is protected with concrete panels with some patches of stone in front. The crest and rear slope are overgrown. The toe of the concrete panels is steadily deteriorating and there is very little or no protective saltmarsh in front. Although there is no immediate concern, this section should be monitored with a view for repair and/or improvement works to the lower panels and toe protection in the medium to longer term.

2.1.4 Potton Island

Photo Ref.	Chainage (m)	Condition Assessment
P361-P363	15 - 58 North of swing bridge	POOR. The bank is protected with a mixture of Essex blocks and concrete slabs which have been lost or displaced in places. The toe of the Essex blocks has become exposed and is becoming undermined requiring a priority works repair and improvement. The crest and Essex Blocks are overgrown.
P363-P364	58 - 138	FAIR. The bank is protected by concrete panels and a narrow strip of saltmarsh. At the northern end of the section where the bank is more exposed on the corner (P364), there are signs of more severe erosion which could lead to future undermining of the concrete panels. This section should be monitored and works planned for the medium to longer term to improve the toe protection at this location. The crest, front and rear slope are overgrown.
P364-P368	138 - 495	FAIR. The bank is protected by concrete panels and fronted by saltmarsh with relatively wide channels close to the toe of the bank which appear to be gradually eroding. The crest, front and rear slope are overgrown making an assessment of the face condition difficult. In the corner, the concrete panels appear to be missing (P365 & P366). Although there appears to be no immediate concern, this section should be monitored and works planned for improving the face and toe protection in the medium to longer term.
P368-P370	495 - 601	FAIR. The bank is protected by concrete panels and fronted by saltmarsh with relatively wide channels close to the toe of the bank which appear to be gradually eroding. The crest, front and rear slope are overgrown making an assessment of the face condition difficult.
P370-P372	601 - 754	FAIR. The bank is protected by newer concrete panels and fronted by saltmarsh with relatively wide channels close to the toe of the bank which appear to be gradually eroding. The crest and rear slope are overgrown.
P372-P382	754 - 854	POOR. The bank is protected by concrete panels with isolated sections of saltmarsh in front. The crest, front and rear slope are overgrown. The panels have disintegrated along the majority of this length and the toe structure have become exposed and is being actively undermined in several places. Such repairs that have been attempted along this section appear ineffective. Priority works are required along this section to replace the existing toe structure, to stabilise the bank above, to replace the deteriorated face slabs, and to provide rock erosion protection at the toe.
P382-P386	854 - 1131	FAIR. The bank is protected by concrete panels with a narrow strip of saltmarsh in front. The crest, front and rear slope are overgrown.
P387-P395	1131 - 1193	POOR. The bank is protected by concrete panels and Essex blocks with little or no saltmarsh in front. The crest, front and rear slope are overgrown. The panels have disintegrated along the majority of this length and the toe structure have become exposed and is being actively undermined in several places. The flood panels installed at the causeway access location need to be replaced or improved.
P395-P401	1193 - 1858	FAIR. The bank is protected by concrete panels with relatively wide saltmarsh in front. The crest, front and rear slope are overgrown.
P401-P406	1858 - 1889	POOR. The bank is protected by concrete panels and Essex blocks. There is no protective saltmarsh in front. The toe structure is exposed and the Essex blocks and panels are badly deteriorated and deformed/missing in places. Priority works are required along this

Photo Ref.	Chainage (m)	Condition Assessment
		section to replace the existing toe structure, to stabilise the bank above, to replace the deteriorated face slabs and Essex blocks, and to provide stone erosion protection at the toe. The crest, front and rear slope are also overgrown. Sluice at ch1865m (P403).
P405-P407	1889 - 2191	FAIR. The bank is protected by concrete panels and Essex blocks with relatively wide saltmarsh in front. The front and rear slope are overgrown. The crest has been grazed by cattle and is eroded.
P407-P412	2191 - 2309	FAIR. The bank is protected by newer concrete panels with relatively wide saltmarsh in front. The crest has been grazed by cattle and is eroded.
P413-P416	2324 - 2355	POOR. The bank is protected by concrete panels and Essex blocks with no protective saltmarsh in front. The rear slope is overgrown. The crest has been grazed by cattle and is eroded. The toe protection has eroded along this section and the concrete panels and Essex blocks have deteriorated to a degree that warrants priority repair and improvement works to stabilise the toe structure, repair/replace the panels above, and replace the rock protection to the toe.
P416-P418	2355 - 2436	FAIR. The bank is protected by newer concrete panels and Essex blocks on the upper face. There is some small size rock protection at the toe. The upper front and rear slope are overgrown. The crest has been grazed by cattle and is eroded.
P417-P424	2436 - 2491	POOR. The bank is protected by concrete panels with Essex blocks to the upper face, with no protective saltmarsh in front. The front and rear slope are overgrown. The crest has been grazed by cattle and is eroded. The toe protection has eroded along this section and the lower concrete panels have deteriorated (exposing the original stone pitching beneath in places) to a degree that warrants priority repair and improvement works to the toe and front face, which should include the replacement of the eroded rock protection at the toe.
P424-P426	2491 - 2560	FAIR. The bank is protected by concrete panels on the upper face with a more recent and substantial concrete toe apron in front. There is some small size rock protection at the toe of the concrete apron. The crest has been grazed by cattle and is eroded.
P426-P431	2560 - 2598	POOR. The bank is protected by concrete panels with Essex blocks to the upper face. The upper Essex blocks appear to be missing in places. The crest has been grazed by cattle and is eroded. The toe protection has eroded along this section, exposing the toe structure which is at risk of being undermined. The lower concrete panels have also eroded (exposing the original stone pitching beneath in places) and have deteriorated to a degree that warrants priority repair and improvement works to the toe and front face, and which should include the replacement of the eroded rock protection at the toe.
P431-P440	2598 - 3002	FAIR. The bank is protected by concrete panels and Essex blocks which have deteriorated, though not as severely as adjacent sections. There is a narrow strip of saltmarsh in front that appears to be eroding slowly and has narrowed significantly in places (see P434 and P440). The front and rear slope are overgrown in places. The crest has been grazed by cattle and is eroded. This section should be monitored and improvement works planned here for the medium to longer term.
P441-P448	3002 - 3134	POOR. The bank is protected by concrete panels with Essex blocks. The front and rear slope are slightly overgrown. The crest has been grazed by cattle and is eroded. The toe protection has eroded along this section, exposing the toe structure which has failed and is actively

Photo Ref.	Chainage (m)	Condition Assessment
		being undermined. The Essex blocks are being deformed and displaced. This section requires priority repair and improvement works to the toe and front face, and which should include the replacement of the eroded rock protection at the toe.
P450	3134 - 3181	FAIR. There is a short section around this location where the erosion of the toe and condition of the bank protection is slightly improved due to the presence of a slightly wider strip of saltmarsh. This section should be monitored at least, and it would seem prudent to include the improvement of this section in the more urgent works either side.
P451-P460	3181 - 3261	POOR. The bank is protected by concrete panels with Essex blocks. The crest has been grazed by cattle and is eroded. The toe protection has previously eroded along this section, exposing the toe structure which had failed and was being undermined. Rock armour has been placed at the toe along this section in an attempt to repair the damage. However, the works do not appear to have addressed the underlying issue of the failed toe structure and deformed Essex blocks above. Therefore, the condition of the toe structure and Essex blocks is likely to further deteriorate over time. This section requires priority repair and improvement works to replace the toe structure and repair or replace the front face protection, then replace the rock toe protection.
P462-P464	3261 - 3322	FAIR. The bank is protected by concrete panels with Essex blocks. The front and rear slope are overgrown. The crest has been grazed by cattle and is eroded. This section has received rock protection at the toe, but the condition of the Essex blocks and lower portion of the bank is better than the preceding section. This section should be monitored and works planned for the medium term to repair and improve the defence before the stability of the toe is threatened.
P464-P465	3322 - 3404	FAIR. The bank is protected by concrete panels with Essex blocks with saltmarsh in front. The crest has been grazed by cattle and is eroded. This section should be monitored and works planned for the medium term to repair and improve the defence before the stability of the toe is seriously threatened.
P465-P472	3404 - 3558	FAIR. The bank is protected by concrete panels with Essex blocks. The crest has been grazed by cattle and is eroded. This section has also received rock protection at the toe, but the condition of the Essex blocks and lower portion of the bank is better than other sections. This section should be monitored and works planned for the medium to longer term to repair and improve the defence before the stability of the toe is seriously threatened.
P472-P485	3558 - 4595	FAIR. The bank is protected by concrete panels with Essex blocks and a relatively healthy and wide saltmarsh in front. The front and rear slope are overgrown. The crest has been grazed by cattle and is eroded.
P485-P488	4595 - 4636	FAIR. The bank is protected by concrete panels with Essex blocks. The saltmarsh narrows at this point, however some rock is present on the foreshore and the bank toe structure does not appear to be under immediate threat. The front and rear slope are overgrown. The crest has been grazed by cattle and is eroded.
P488-P495	4636 - 5829	FAIR. The bank is protected by Essex blocks and a relatively healthy and wide saltmarsh in front. The front and rear slope are overgrown making the condition of the front face difficult to establish. The crest and base of the bank has been grazed by cattle and is eroded.
P495-P498	5829 - 5896	FAIR. The bank is protected by Essex blocks and concrete panels. The saltmarsh narrows at this point and the base of the panels is subject to

Photo Ref.	Chainage (m)	Condition Assessment
		gradual erosion. The front and rear slope are overgrown. The crest and base of the bank has been grazed by cattle and is badly eroded. This section should be monitored and works planned for the medium to longer term to improve the defence and replace the toe protection.
P498-P515	5896 - 6114	POOR. The bank is protected with Essex blocks. The front and rear slope are overgrown. The crest has been grazed by cattle and is eroded. The toe protection has eroded along this section, exposing the toe structure which has failed and is actively being undermined. The Essex blocks are being deformed and displaced. This section requires priority repair and improvement works to the toe and front face, and which should include the replacement of the eroded rock protection at the toe. The condition of the bank immediately either side of the sluice at ch6036m (P505) is also POOR and the foundations of the sluice structure are at risk of failure.
P516-P522	6114 - 6990	FAIR. The bank is protected with stone pitching and is fronted by relatively wide, healthy saltmarsh. The front and rear slopes are overgrown. The crest and base of the bank has been grazed by cattle and is eroded.
P523-P524	6990 - 7010	POOR. There is a break in the fronting saltmarsh at the location of the sluice at ch7000m. There is no bank protection at this point and the bank has severely eroded to the point where the sluice structure is dangerously undermined and at risk of failure.
P526-P540	7010 - 8195	FAIR. The bank is protected with stone pitching and is fronted by relatively wide, healthy saltmarsh. The front and rear slopes are overgrown. The crest and base of the bank have been grazed by cattle and are badly eroded (see P530, P534-P536) where the bank condition should be monitored if the current grazing practices continue.
P540-P541	8195 - 8205	POOR. There is a break in the fronting saltmarsh and the bank has eroded and become undermined. The upper portion of the bank face is protected with concrete but this is deteriorating. Some rock protection has been added in the past, but this is now in POOR condition and is not effective at preventing further erosion. The crest and base of the bank has been grazed by cattle and is eroded. This section requires priority works to stabilise the base of the bank by reconstructing the toe structure and panels, and protecting the toe with rock.
P543-P557	8205 - 8734	FAIR. The bank is protected with concrete panels and is fronted by saltmarsh which narrows in places. The front, crest and rear slopes are overgrown. Sluice at P557.
P557-P569	8734 - 9097	FAIR. The bank is protected with Essex blocks and is fronted by saltmarsh which narrows in places. The front, crest and rear slopes are badly overgrown. The height of the seaweed line suggests that this section overtopped during the Dec 2013 and is generally low, so the section should be monitored particularly around high tide and/or surge events, and short to medium term works planned to improve the protection to the bank toe where the saltmarsh has eroded and to raise the defence height.
P570-P574	9097 - 9155 South of swing bridge	POOR. The bank is protected with Essex blocks and concrete slabs and is not protected by saltmarsh. The front, crest and rear slopes are badly overgrown. The toe structure has failed and the concrete slabs are being actively undermined and displaced. Priority works are required here to construct a sound toe structure, repair/replace the front face and to add rock protection at the toe.

2.2 Current and Required Standard Protection

2.2.1 General

Exposure to significant wave action varies around the site. The Thames Estuary frontage between Shoeburyness and Havengore Bridge and from Havengore Bridge anticlockwise around Foulness Island to a point north of ETC (taken as Ch2050m) can be exposed to more significant wave action because the available fetch (distance over sea that the wind can blow) is relatively large. For these frontages, the standard of protection must take into account extreme water levels and wave heights in combination. For the remainder of Foulness and Potton Island (where frontages face the Rivers Roach and Crouch) wave action is assumed to be negligible, hence the standards of protection determined are based on extreme water levels only. See Figure 2.2.1 below.

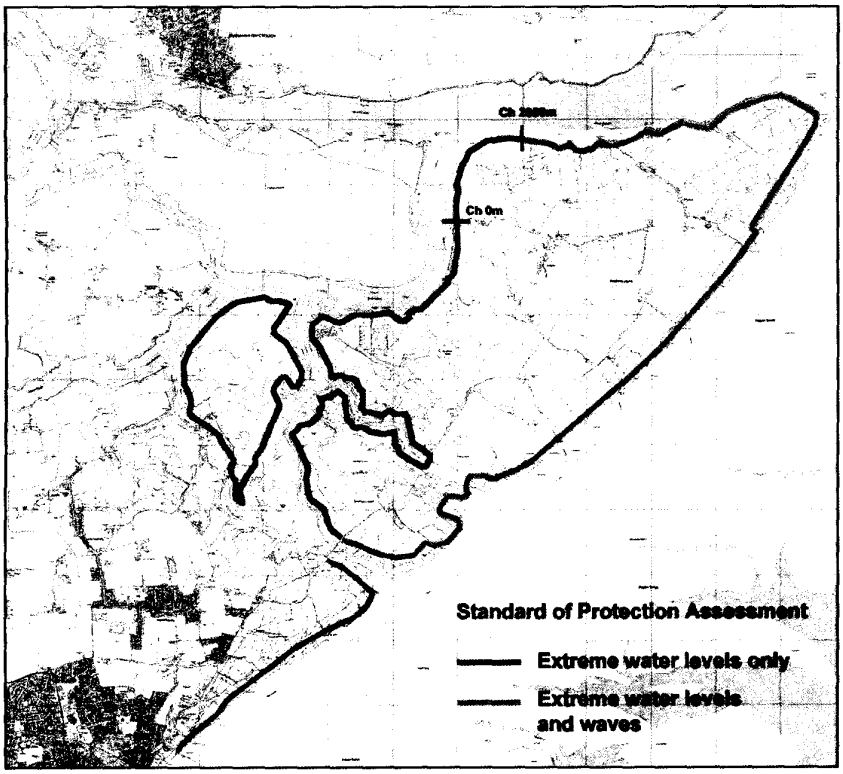


Figure 2.2.1 – Basis for Standard of Protection (SoP) assessment

2.2.2 River Frontages

For the river frontages of Foulness Island and Potton Island, wave action is considered to be significantly less than on the open coast. This has been borne out by advice received from : staff. The Standard of Protection (SoP) for these river frontages was determined by considering the extreme water level for a range of return periods. When determining the SoP of a particular frontage, a freeboard allowance of 300mm was applied to account for the fact that the floodbanks are in general heavily overgrown and to account for the likely risk that the banks are affected by vermin activity and likely to be cracked and fissured in places. This is standard industry practice for such assessments. The practical effect of allowing such a freeboard allowance is that the effective height of the flood bank is considered 300mm lower than the actual LiDAR survey values reported.

The extreme water levels considered applicable in determining the SoP of the river frontages are given in Table 2.2.1 below, taken for Point 4294 from the Environment Agency report 'Coastal Flood Boundary Conditions for UK Mainland and Islands - Practical Guidance Design Sea Levels' (2011). Table 2.2.1 also

indicates the required standard of protection in 2014 and in 2064, allowing for sea level rise which has been taken from DEFRA UKCP 09 (http://ukclimateprojections-ui.metoffice.gov.uk/ui/start/start.php)

Table 2.2.1 – Required Crest Heights (in mODN) to Achieve Stated SoP (extreme water level only)

Return Period (Years)	No Freeboard Allowance			Freeboard Allowance of 300mm	
	2014	2064		2014	2064
5	3.75	3.96		4.05	4.26
10	3.88	4.09		4.18	4.39
20	4.00	4.21		4.30	4.51
50	4.18	4.39		4.48	4.69
100	4.30	4.51		4.60	4.81
200	4.44	4.65		4.74	4.95
500	4.61	4.82		4.91	5.12

2.2.2.1 Foulness Island

The standard of protection for the Foulness Island river frontage (Ch0 to Ch2050m and Ch19200 to Ch31790m) was determined to be as follows:

In Year 0 (2014):

- 33% of the bank is < 1 in 200 year standard (4.44 + 0.3) or < 4.74 mODN)
- 15% of the bank is < 1 in 100 year standard (4.30 + 0.3) or < 4.60 mODN)
- 6% of the bank is < 1 in 50 year standard (4.18 + 0.3) or < 4.48 mODN)
- 1% of the bank is < 1 in 20 year standard (4.00 + 0.3) or < 4.30 mODN)
- 1% of the bank is < 1 in 10 year standard (3.88 + 0.3) or < 4.18 mODN)
- 1% of the bank is < 1 in 5 year standard (3.75 + 0.3) or < 4.05 mODN)

In Year 50 (2064), with predicted sea level rise:

- 69% of the bank will be < 1 in 200 year standard (4.65 + 0.3) or < 4.95 mODN)
- 45% of the bank will be < 1 in 100 year standard (4.51 + 0.3) or < 4.81 mODN)
- 23% of the bank will be < 1 in 50 year standard (4.39 + 0.3) or < 4.69 mODN)
- 8% of the bank will be < 1 in 20 year standard (4.21 + 0.3) or < 4.51 mODN)
- 3% of the bank will be < 1 in 10 year standard (4.09 + 0.3) or < 4.39 mODN)
- 1% of the bank will be < 1 in 5 year standard (3.96 + 0.3) or < 4.26 mODN)

The required indicative standard of protection for Foulness Island (based on DEFRA Project Appraisal Guidance and English Nature advice in consideration of the designated environmental assets) is **1 in 100 year standard in Year 50**. The required crest height to achieve this is +4.81 mODN (including a 0.3 m freeboard allowance).

Currently, only 55% of the bank provides this standard of protection or higher, hence approximately **45% of the Foulness Island bank length (for the Roach & Crouch frontage) would need to be raised to meet the required standard.**

Note that the proposed crest height to provide a 1 in 100 year standard in Year 50 (+4.81m ODN) would provide a greater than 1 in 200 year standard today (2014).

The current standard of protection at Foulness Island (between Ch0m to Ch2050m and Ch19200m to Ch31790m) is shown on Figures 2.2.2, 2.2.3 and 2.2.4 below, and may also be viewed in the TatukGIS database on the DVD.

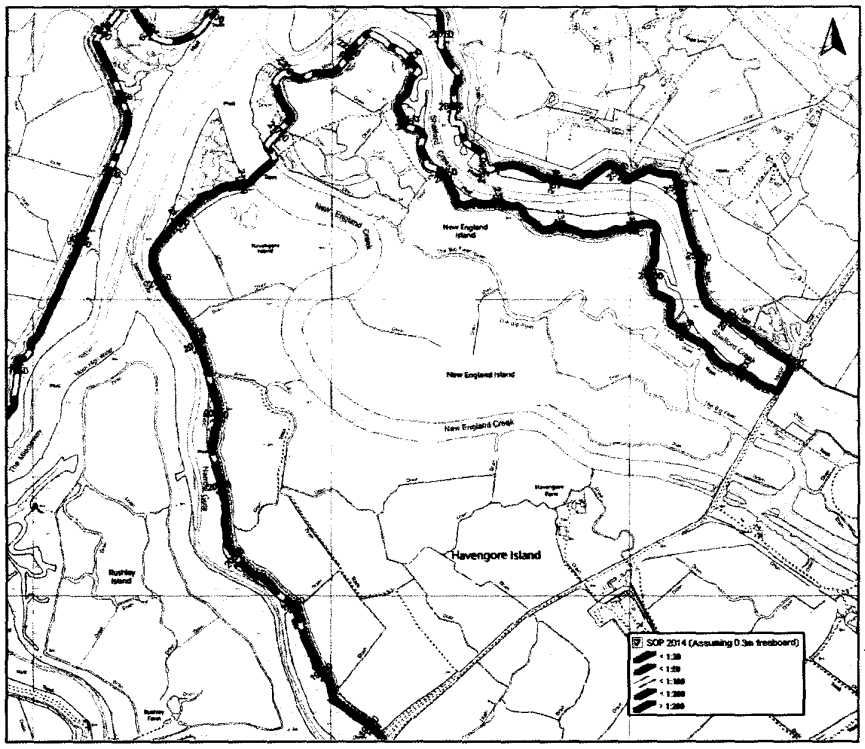


Figure 2.2.2 – Current (2014) Standard of Protection, Foulness Island (Roach & Crouch river frontage) – 1 of 3

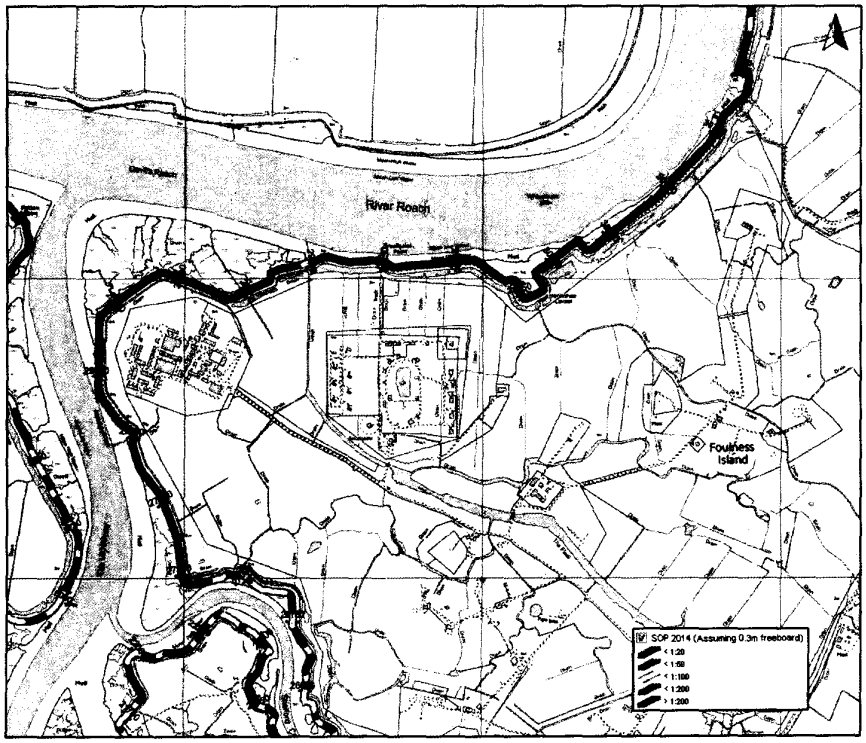


Figure 2.2.3 – Current (2014) Standard of Protection, Foulness Island (Roach & Crouch river frontage) – 2 of 3

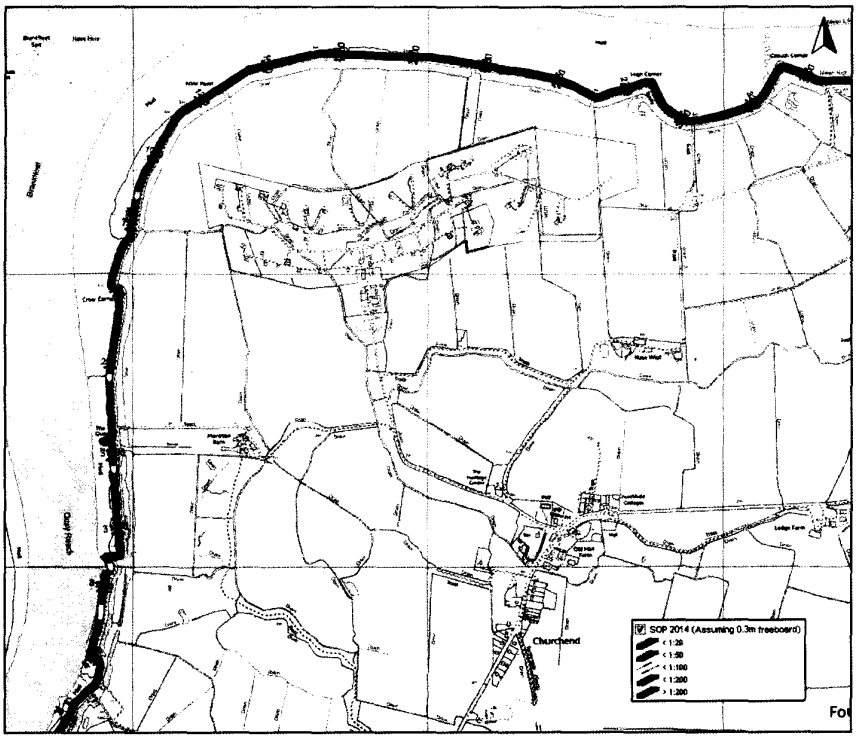


Figure 2.2.4 – Current (2014) Standard of Protection, Foulness Island (Roach & Crouch river frontage) – 3 of 3

2.2.2.2 Potton Island

The standard of protection of Potton Island was determined to be as follows:

In Year 0 (2014):

- 43% of the bank is < 1 in 50 year standard (4.18 + 0.3) or < 4.48 mODN)
- 19% of the bank is < 1 in 20 year standard (4.00 + 0.3) or < 4.30 mODN)
- 7% of the bank is < 1 in 10 year standard (3.88 + 0.3) or < 4.18 mODN)
- 3% of the bank is < 1 in 5 year standard (3.75 + 0.3) or < 4.05 mODN)

In Year 50 (2064), with predicted sea level rise:

- 81% of the bank will be < 1 in 50 year standard (4.39 + 0.3) or < 4.69 mODN)
- 49% of the bank will be < 1 in 20 year standard (4.21 + 0.3) or < 4.51 mODN)
- 30% of the bank will be < 1 in 10 year standard (4.09 + 0.3) or < 4.39 mODN)
- 14% of the bank will be < 1 in 5 year standard (3.96 + 0.3) or < 4.26 mODN)

The required indicative standard of protection for Potton Island (based on DEFRA Project Appraisal Guidance and English Nature advice in consideration of the designated environmental assets) is **1 in 20 year standard in Year 50**. The required crest height to achieve this is +4.51 mODN (including a 0.3 m freeboard allowance).

Currently, only 51% of the bank provides this standard of protection or higher, hence approximately **49% of the Potton Island bank length would need to be raised to meet the required standard.**

Note that the proposed crest height to provide a 1 in 20 year standard in Year 50 (+4.51 mODN) is approximately equivalent to a 1 in 50 year standard today (2014).

The current standard of protection at Potton Island is shown on Figures 2.2.5 and 2.2.6 below.

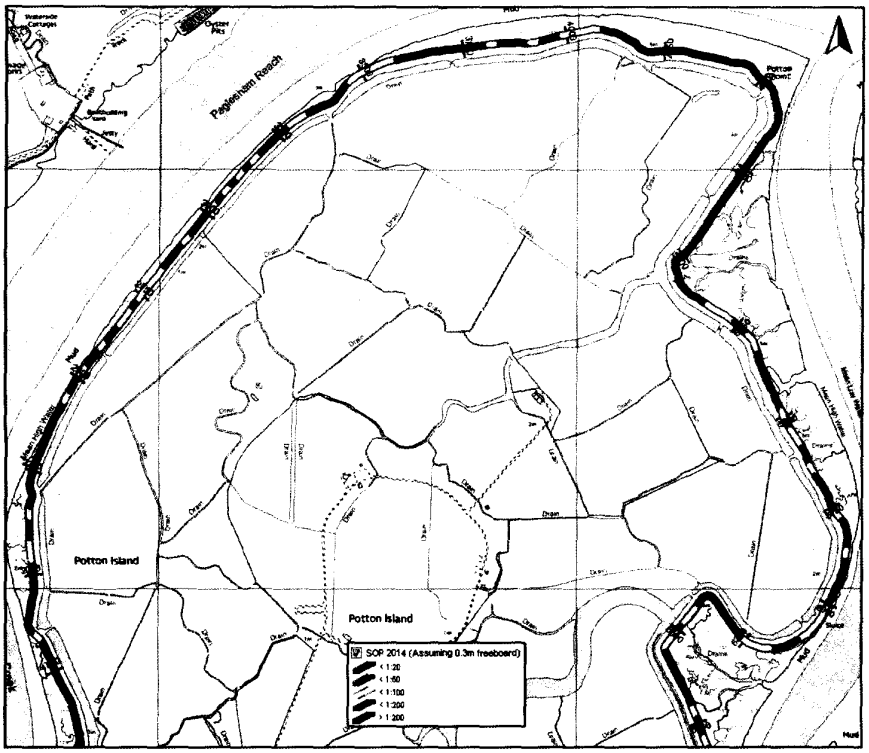


Figure 2.2.5 – Current (2014) Standard of Protection, Potton Island (North)

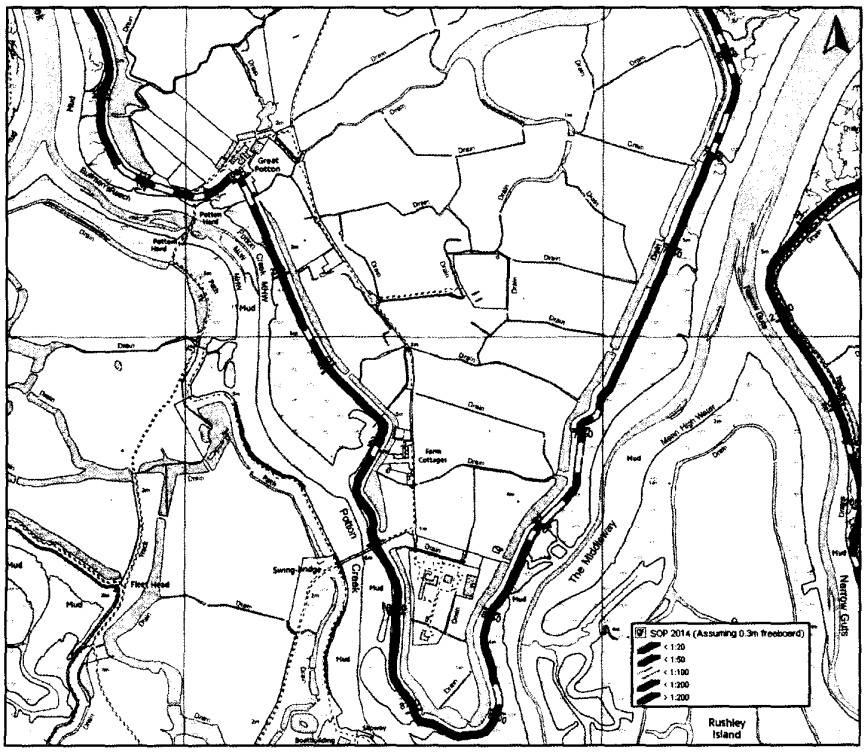


Figure 2.2.6 – Current (2014) Standard of Protection, Potton Island (South)

Note: To help determine the risk of flooding from overtopping at the site, currently use a spreadsheet containing the crest levels for a portion of the flood walls around the site. For a given water level, the spreadsheet reports which sections of wall would overtop. As part of the study, existing spreadsheet was updated by Halcrow-CH2M HILL to include crest height data for the whole of the site including Shoeburyness, Potton Island and all of Foulness Island (based on the LiDAR data obtained for the study). The updated calculator includes a freeboard allowance, and an extreme water level calculator to calculate the magnitude of extreme water level events in the future, allowing for sea level rise. A copy of the updated calculator is included on the accompanying this report. A screenshot of the calculator is shown in Figure 2.2.7 below.

OVERTOPPING CALCULATOR FOR FOULNESS ISLAND

How to use this calculator:

1) Enter the extreme water level (in mODN) you are interested in into Cell E4. This can be any high water level eg a warning level provided by the Environment Agency, or a water level output from the Extreme Water Level Calculator.
2) Enter a wave height (if desired) into Cell J4.
3) Enter the datum correction from Chart Datum to Ordnance Datum Newlyn in Cell P4 (in metres). Note: for Southend, this is 2.90m.

The number of reference locations along the Foulness frontage where the wall height is exceeded by the extreme water level entered in Cell G4 (including wave height if entered), and the percentage length of the frontage this represents, are given in Row 6 below. Individual reference locations are highlighted in orange where less that 0.3 m freeboard is present and in red where the wall height is exceeded.

Extreme Water Level (mODN):	4.51	Wave Height (m):	0.00	Chart Datum Correction (m):	2.90
NUMBER OF LOCATIONS ON FOULNESS WHERE WALL IS EXCEEDED:	51	PERCENTAGE OF FOULNESS FRONTAGE WHICH IS OVERTOPPED:	5.7%		
		PERCENTAGE OF FOULNESS FRONTAGE WHERE FREEBOARD IS LESS THAN 300 MM:	[redacted]		

Point Ref	Chainage (m)	Easting OSGB (m)	Northing OSGB (m)	Wall Height (mODN)	Water Level (mODN)	Water Level with Wave (mODN)	Freeboard (m)	Water Level (mCD)	Status
001	0	598925.8	193433.2	4.88	4.51	4.51	0.37	7.41	OK
002	25	598932.0	193455.0	4.59	4.51	4.51	0.08	7.41	[redacted]
003	50	598931.3	193480.1	4.74	4.51	4.51	0.23	7.41	[redacted]
004	75	598929.6	193505.0	4.66	4.51	4.51	0.15	7.41	[redacted]
005	100	598926.9	193529.8	4.71	4.51	4.51	0.20	7.41	[redacted]
006	125	598926.7	193554.7	4.63	4.51	4.51	0.12	7.41	[redacted]
007	150	598925.4	193579.6	4.63	4.51	4.51	0.12	7.41	[redacted]
008	175	598924.3	193604.6	4.74	4.51	4.51	0.23	7.41	[redacted]
009	200	598923.4	193629.6	4.81	4.51	4.51	0.30	7.41	[redacted]
010	225	598923.0	193654.2	4.59	4.51	4.51	0.08	7.41	[redacted]
011	250	598926.1	193679.0	4.84	4.51	4.51	0.33	7.41	OK
012	275	598930.0	193703.7	4.82	4.51	4.51	0.31	7.41	OK
013	300	598933.2	193728.5	4.96	4.51	4.51	0.45	7.41	OK
014	325	598937.0	193753.2	4.91	4.51	4.51	0.40	7.41	OK
015	350	598941.1	193777.8	4.94	4.51	4.51	0.43	7.41	OK
016	375	598945.2	193802.5	5.20	4.51	4.51	0.69	7.41	OK
017	400	598948.4	193827.3	5.22	4.51	4.51	0.71	7.41	OK
018	425	598951.1	193852.1	5.16	4.51	4.51	0.65	7.41	OK

Note: Chainage 0 is at The Quay, and runs clockwise around Foulness Island back to The Quay.

Figure 2.2.7 – Screenshot of Updated Water Level and Overtopping Calculator

2.2.3 Coastal Frontages

For the coastal frontage at Shoeburyness and Foulness, which is susceptible to wave action, it was necessary to combine wave heights and extreme water levels to determine the existing Standard of Protection. The joint probability wave height and water level combinations were derived by inputting the marginal extreme water levels and offshore wave heights provided by (from the RF Hunt & Associates report 'Foulness Island Coastal Extreme Wave and Water Level Study', 2013) shown in Table 2.2.2 below.

Chapter 6). These approaches are suitable for all of the defence types present on the coastal frontages of Shoeburyness and Foulness Island. The return periods were tested sequentially from highest to lowest to establish the Standard of Protection for each defence. Thus, the joint probability wave heights and water level combinations for a 1 in 100 RP event were applied first. If the overtopping discharge was greater than the relevant threshold then the 1 in 50 RP combinations were applied.

Table 2.2.4

Overtopping thresholds for defence types present at Shoeburyness and Foulness

Type of Defence	Overtopping Discharge Threshold (l/s/m)
Grass embankment with grass crest and concrete revetment	10
Grass embankment with concrete crest and concrete revetment	20
Vertical concrete wall	50

Table 3.5: Limits for overtopping for damage to the defence crest or rear slope

Hazard type and reason	Mean discharge q (l/s/m)
Embankment seawalls / sea dikes	
No damage if crest and rear slope are well protected	50-200
No damage to crest and rear face of grass covered embankment of clay	1-10
No damage to crest and rear face of embankment if not protected	0.1
Promenade or revetment seawalls	
Damage to paved or armoured promenade behind seawall	200
Damage to grassed or lightly protected promenade or reclamation cover	50

Figure 2.2.8 – Extract from EurOtop (EA/KNFI/ENW, 2007) showing applicable overtopping discharges for damage to the defence crest or rear slope

The following Tables 2.2.5 and 2.2.6 summarise the standard of protection determined for the coastal frontages around the site and the crest level required to achieve the target standard of protection, assuming the structural configuration of the defence remains the same.

Table 2.2.2 – Extreme Wave Heights (from RF Hunt & Associates report, 2013)

Extreme Significant Wave Heights, Hs (m) for offshore locations along Foulness Island used in JPA
**Site M was taken as the most applicable to the study frontage*

RP (years)	Site S	Site M*	Site N	Site H
1	0.98	0.96	1.06	1.17
5	1.06	1.05	1.17	1.32
10	1.09	1.09	1.22	1.38
20	1.12	1.13	1.27	1.44
50	1.16	1.18	1.34	1.50
100	1.19	1.22	1.39	1.55
500	1.27	1.31	1.51	1.76

The marginal extreme values were entered into a joint probability calculator (taken from Environment Agency R&D Technical Report FD2308/TR 2, 2005) applying a "modest" correlation factor (ρ = 0.37 for Sheerness). The results of the JPA used by the study to determine the existing standard of protection of the coastal frontages are shown in Table 2.2.3 below.

Table 2.2.3 – Joint Probability of Waves and Water Levels for 2014 and 2064

Joint Probability of Wave heights and Extreme Water Levels for 2014 and 2064

		Wave Heights for Joint Return Period, Hm0 (m)						
Extreme Water Level 2014 (mODN)	**Extreme Water Level 2064 (mODN)**	**1**	**5**	**20**	**50**	**100**	**200**	**500**
2.96	3.17	0.88	0.99	1.09	1.16	1.21	1.26	-
3.32	3.53	0.75	0.87	0.96	1.03	1.08	1.13	1.19
3.48	3.69	0.71	0.83	0.92	0.99	1.04	1.09	1.15
3.75	3.96	-	0.74	0.83	0.90	0.95	1.00	1.06
3.88	4.09	-	-	0.80	0.86	0.91	0.96	1.02
4.00	4.21	-	-	0.76	0.82	0.87	0.92	0.98
4.18	4.39	-	-	-	0.77	0.82	0.87	0.93
4.30	4.51	-	-	-	-	0.78	0.83	0.89
4.61	4.82	-	-	-	-	-	-	0.80

The standard of protection for the coastal frontages was determined by applying a limiting threshold to the discharge of water over the defence that is acceptable under a storm event. The limits used in this study are based on guidance from EurOtop (Table 3.5, EA/KNFI/ENW, 2007) and Besley (1998). In the previous study (Halcrow, 2001) the limits recommended by Besley were used; generally, these have been superseded by EurOtop, although where an embankment is protected by a concrete crest the study assumed that the threshold was raised from 10 l/s/m to 20 l/s/m. The overtopping thresholds used are summarised in Table 2.2.4 below and the relevant extract from EurOtop is shown in Figure 2.2.8.

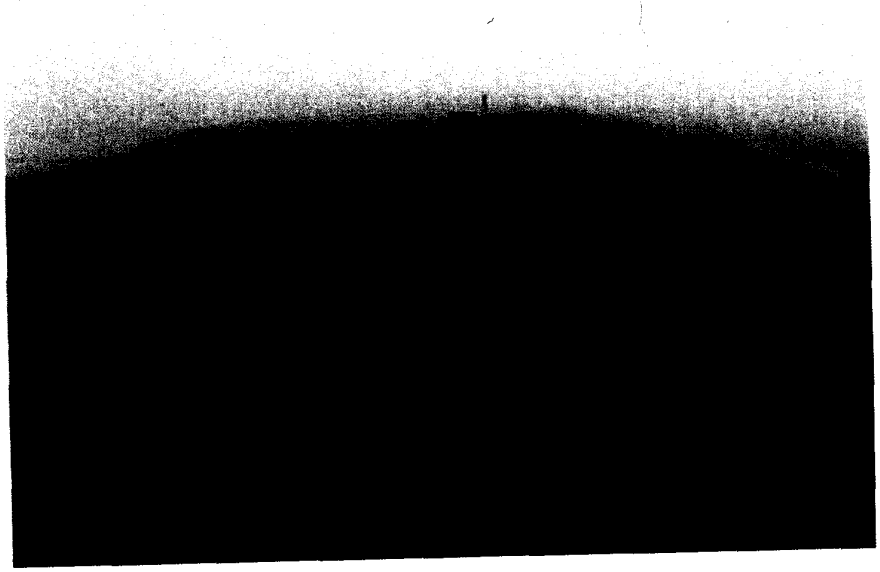
The method used to determine the overtopping is the safety assessment for coastal dykes and embankment sea walls (as described in Chapter 5 of EurOtop) and for vertical walls (as described in

Table 2.2.5 – Existing and Required Standard of Protection, Shoeburyness Frontage

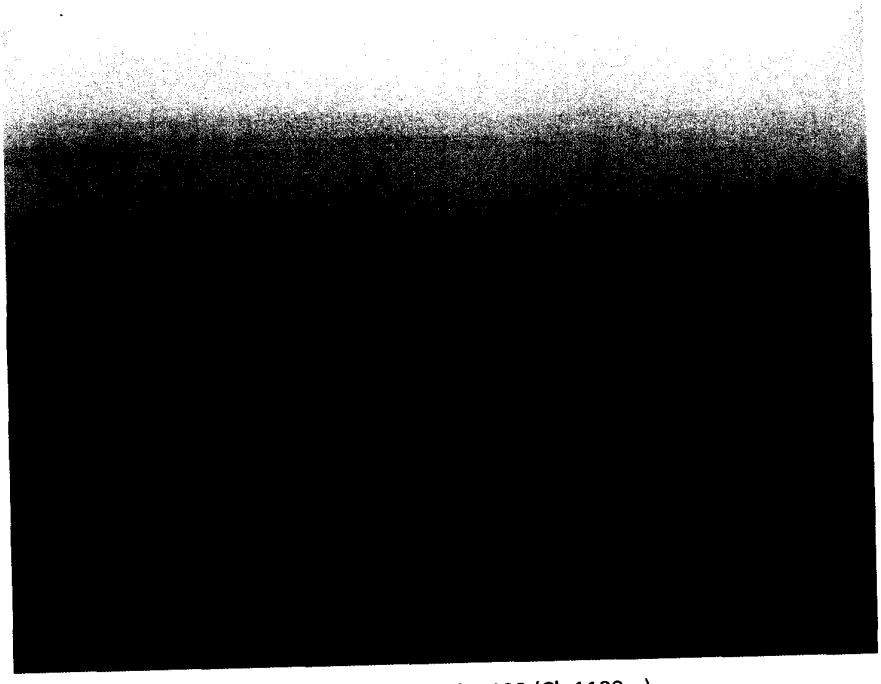
Section	Chainage From / To	Section Length (m)	Threshold l/s/m (EurOtop)	SOP in 2014 (years)	SOP in 2064 (years)	Required Crest Level in Year 50 (mOD)
A1	0 – 520	520	50	> 100	> 100	N/A
A2	520 – 1025	505	50	> 100	> 100	N/A
A3	1025 – 1215	190	10	20-50	5-20	5.65
A4.1	1215 – 1325	110	10	20-50	5-20	5.65
A4.2	1325 – 1550	225	-	>100	>100	5.65
A5	1550 – 1660	110	10	5-20	5-20	5.65
A6	1660 – 1920	260	10	20-50	5-20	5.65
A7	1920 – 2120	200	10	50-100	>100	N/A
A8	2120 – 2450	330	10	20-50	5-20	5.65
A9.1	2450 – 3100	650	10	5-20	1-5	5.65
A9.2	3100 – 3220	120	10	5-20	1-5	5.65
A10	3220 – 4264	1030	10	5-20	1-5	5.65
A11.1	4264 – 4364	100	10	5-20	5-20	5.65
A11.2	4364 – 5225	861	10	5-20	5-20	5.35

Table 2.2.6 – Existing and Required Standard of Protection, Foulness Coastal Frontage

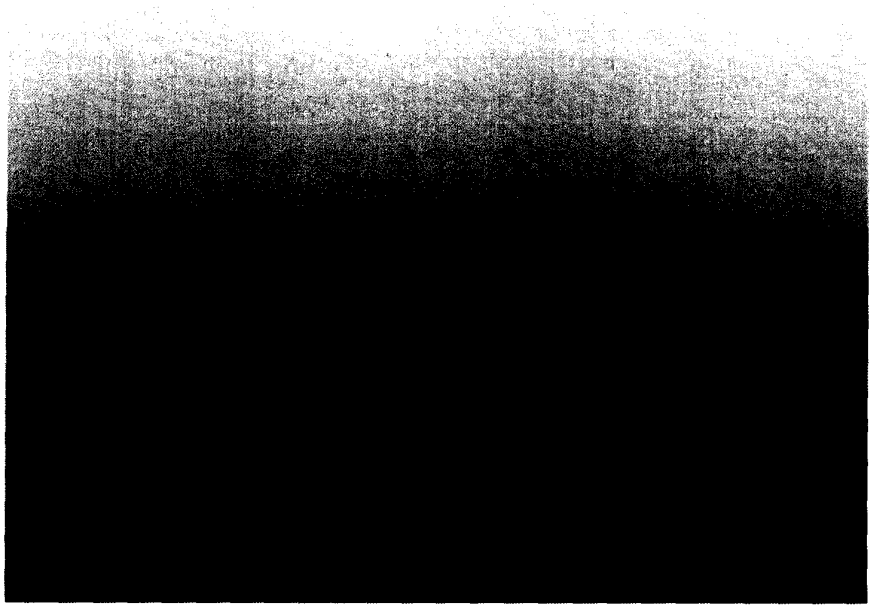
Section	Chainage From / To	Section Length (m)	Threshold l/s/m (EurOtop)	SOP in 2014 (years)	SOP in 2064 (years)	Required Crest Level in Year 50 (mOD)
B1	2050 – 5250	3200	10	5-20	1-5	5.65
C1	5250 – 6750	1500	20	>100	>100	5.43
C2.1	6750 - 7150	400	20	>100	>100	5.43
C2.2	7150 – 9310	2160	10	5-20	1-5	5.65
C3	9310 – 11230	1920	20	20-50	5-20	5.43
C4	11230 – 13800	2570	20	>100	>100	5.43
C5	13800 – 15700	1900	10	20-50	5-20	5.65
C6	15700 – 16700	1000	10	5-20	1-5	5.60
C7	16700 – 17125	425	20	50-100	20-50	5.43
C8.1	17125 – 17375	250	20	50-100	20-50	5.43
C8.2	17375 – 19190	1815	10	5-20	5-20	5.60



Foulness – Photograph P188 (Ch 640m)

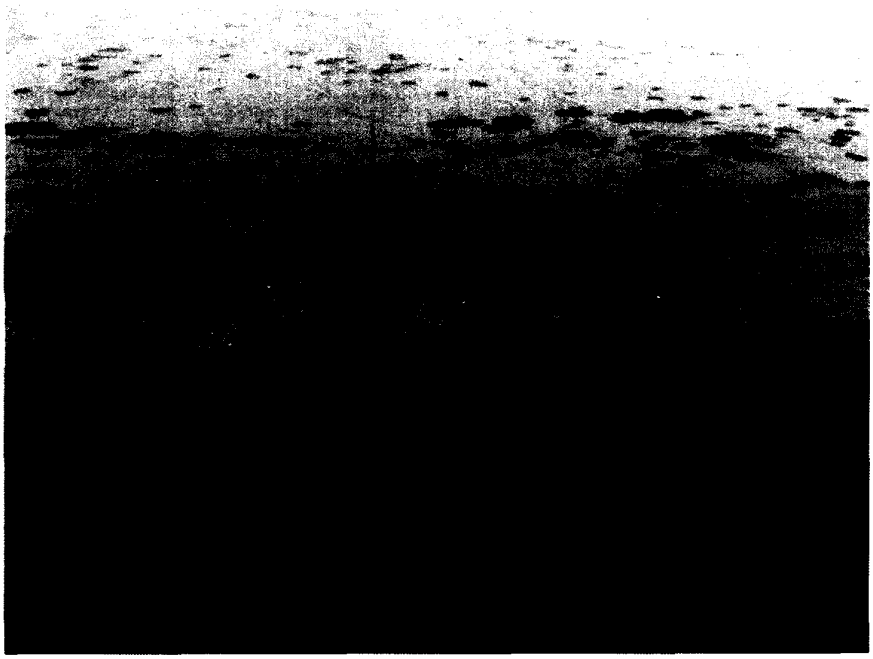


Foulness – Photograph P192 (Ch 1109m)



Foulness – Photograph P193 (Ch 1161m)

Foulness – Photograph P197 (Ch 1615m)

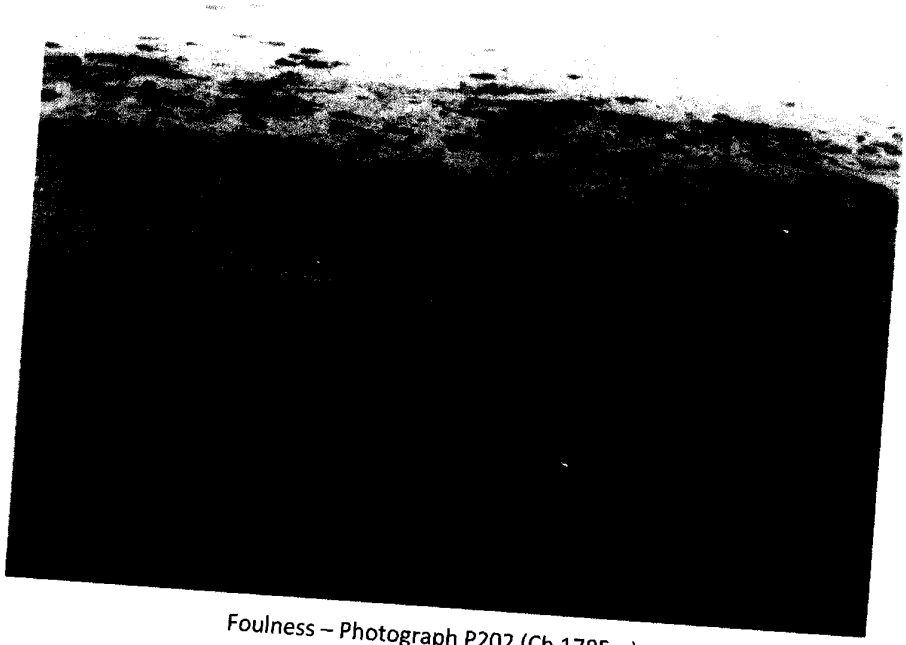


Foulness – Photograph P198 (Ch 1735m)

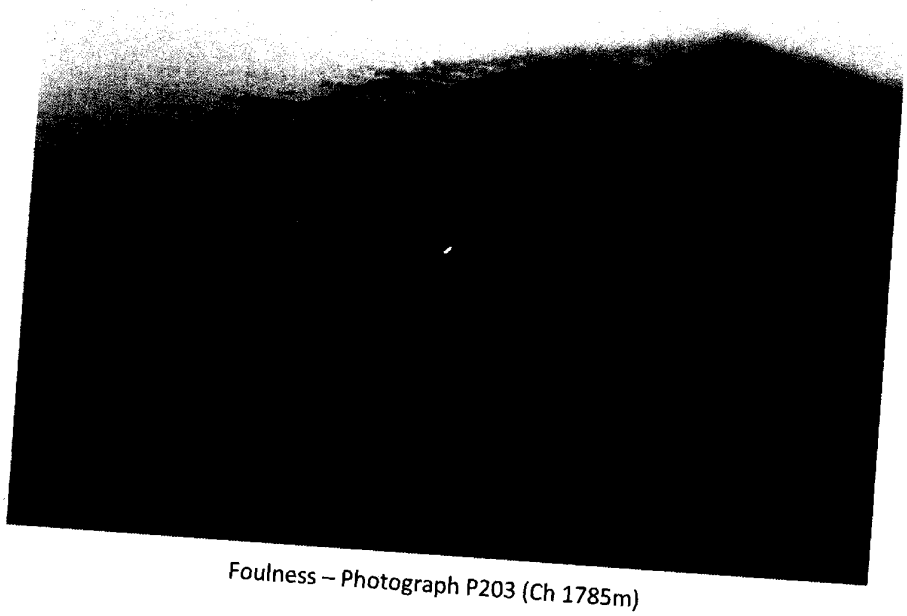
Foulness – Photograph P199 (Ch 1735m)

Foulness – Photograph P200 (Ch 1735m)

Foulness – Photograph P201 (Ch 1785m)



Foulness – Photograph P202 (Ch 1785m)



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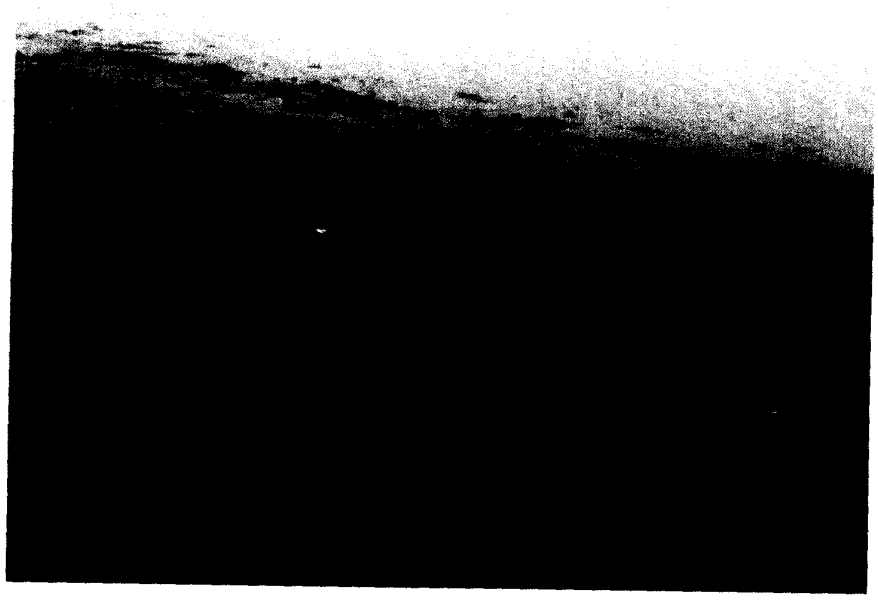
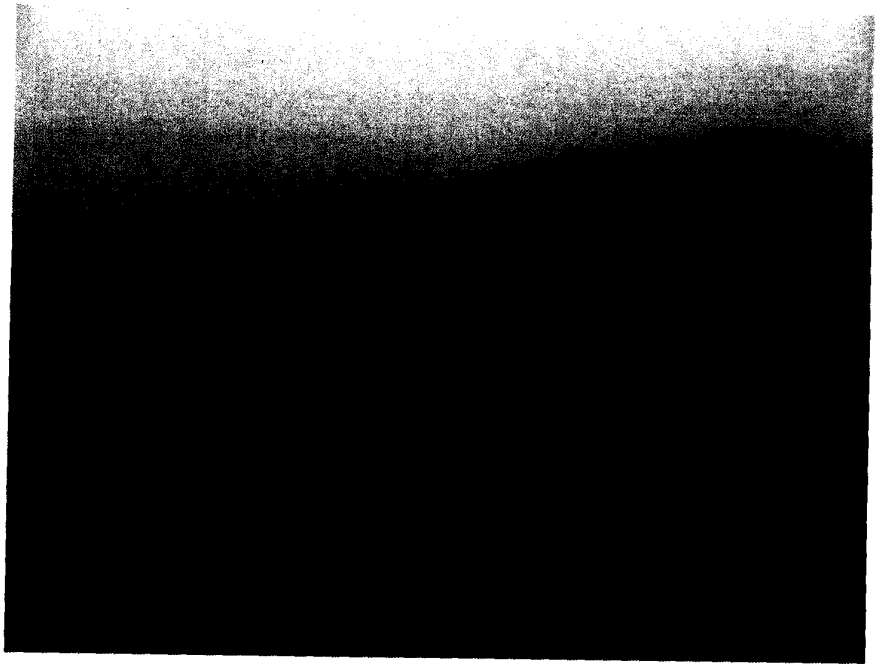


Foulness – Photograph P204 (Ch 1790m)

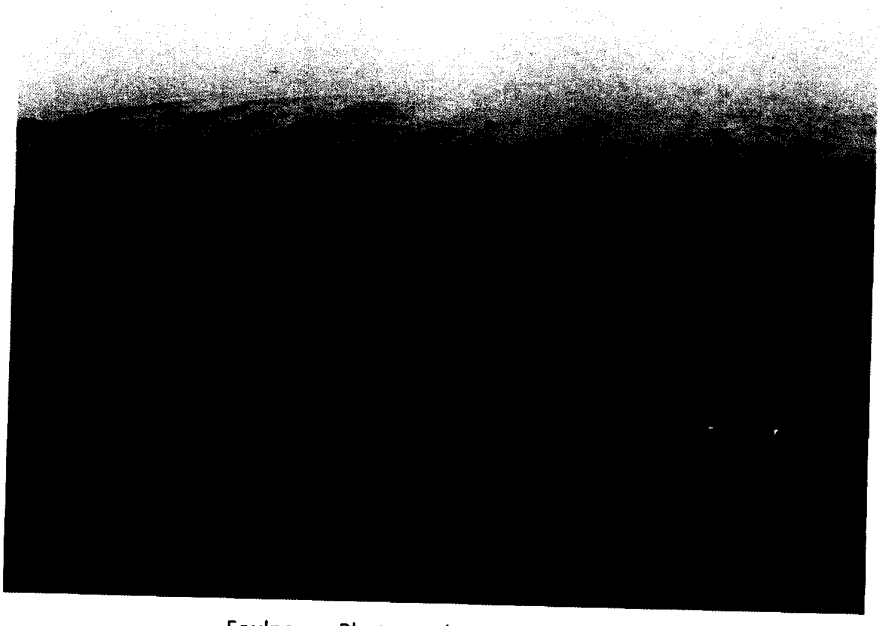


Foulness – Photograph P205 (Ch 1820m)

Foulness – Photograph P206 (Ch 1910m)

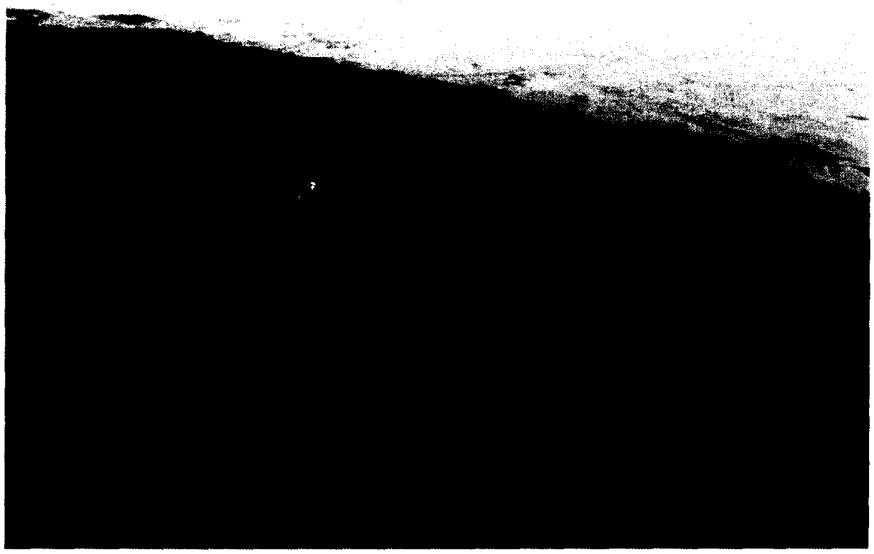
Foulness – Photograph P207 (Ch 1910m)

Foulness – Photograph P208 (Ch 1910m)

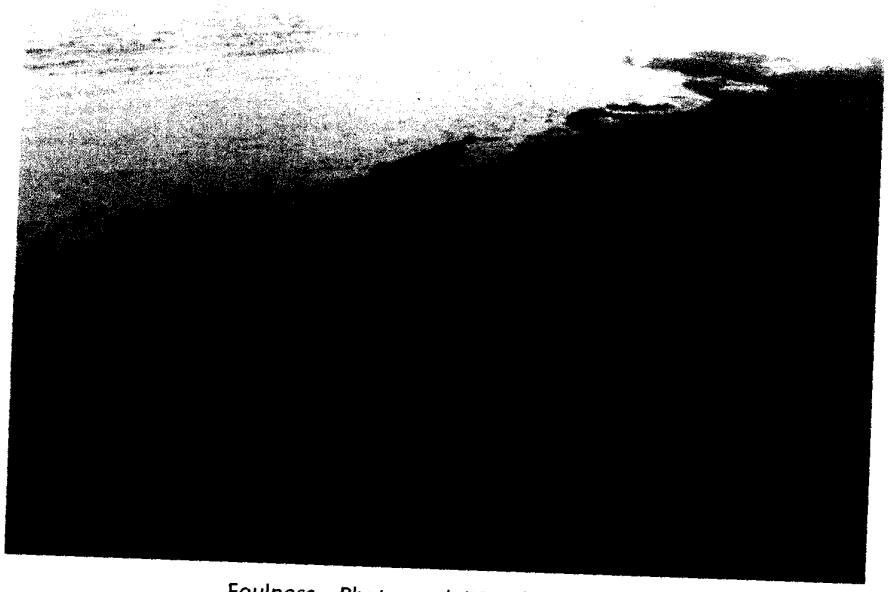


Foulness – Photograph P209 (Ch 1919m)

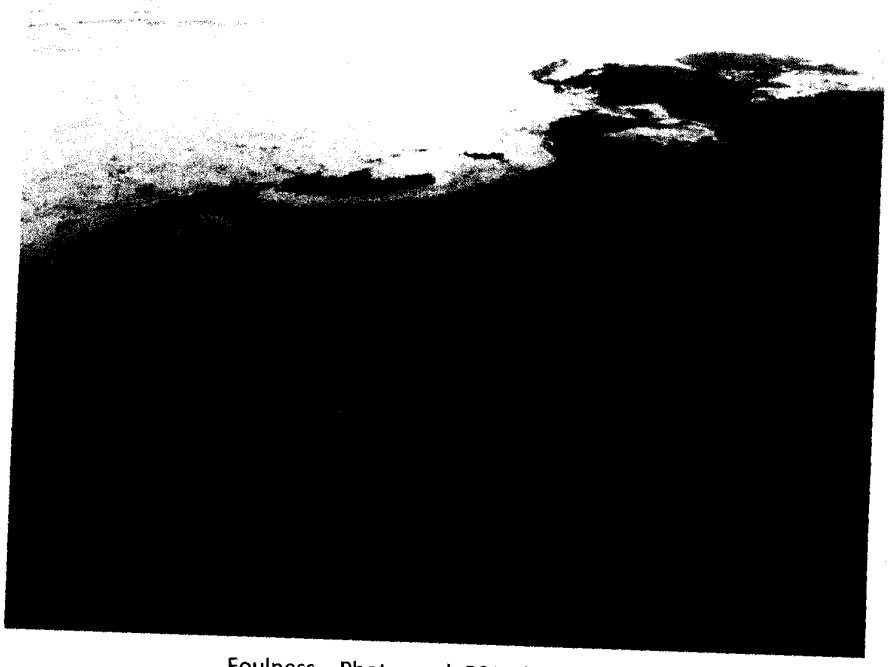
Foulness – Photograph P210 (Ch 2040m)



Foulness – Photograph P211 (Ch 2065m)

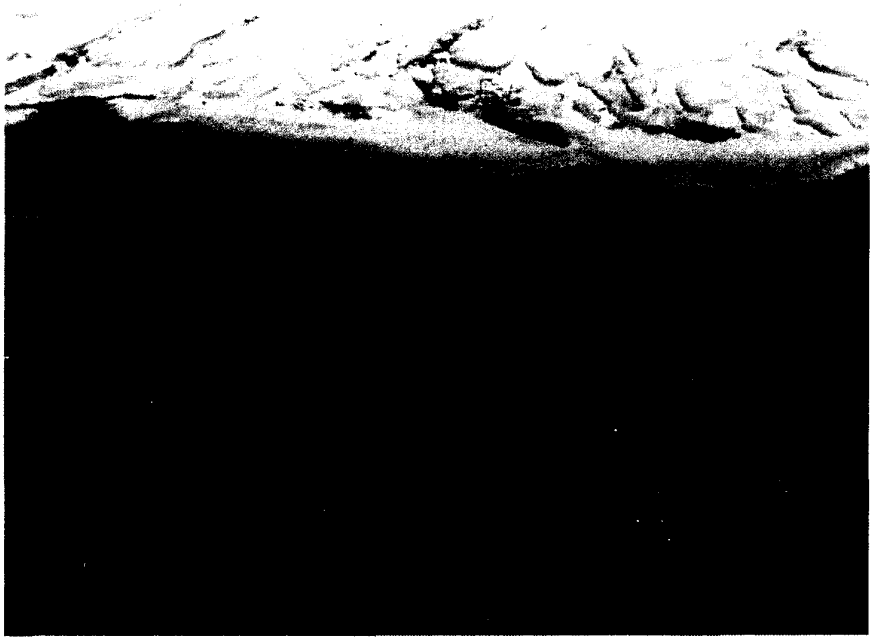


Foulness – Photograph P212 (Ch 2070m)



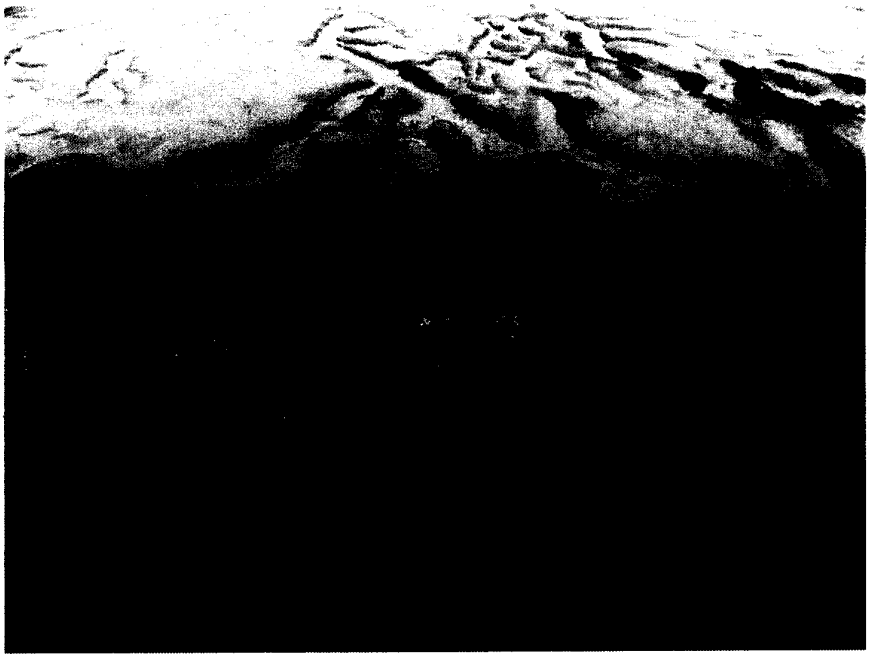
Foulness – Photograph P213 (Ch 2080m)

Foulness – Photograph P214 (Ch 2100m)



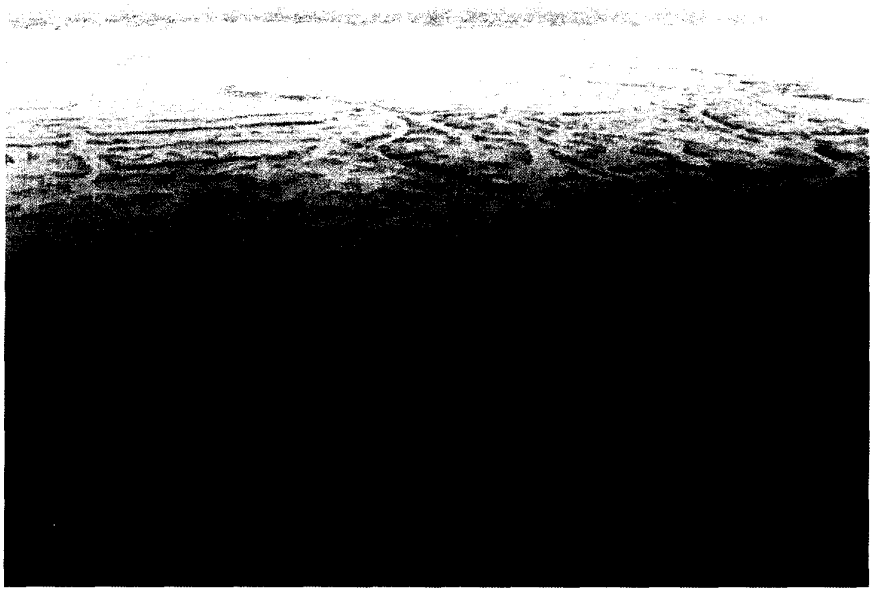
Foulness – Photograph P215 (Ch 2124m)

Foulness – Photograph P216 (Ch 2230m)

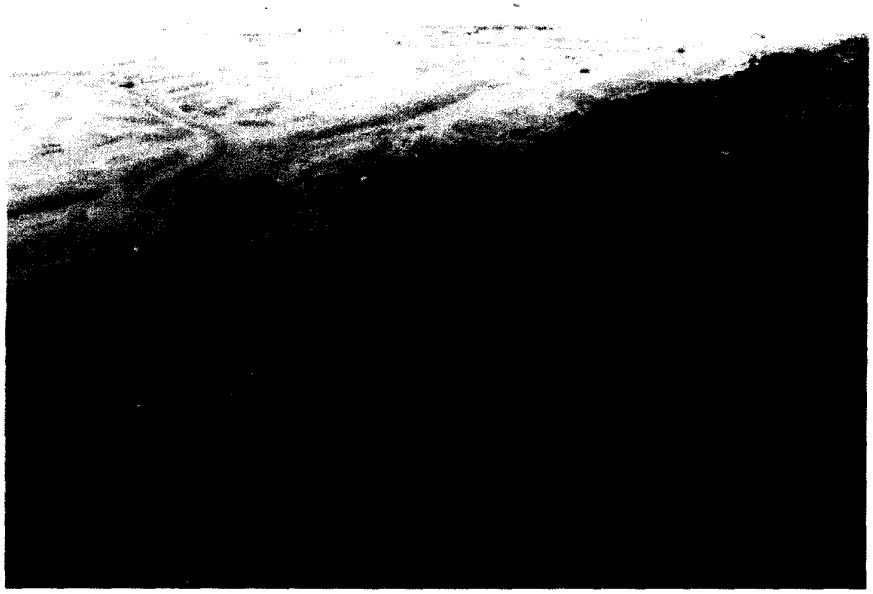


Foulness – Photograph P218 (Ch 2265m)

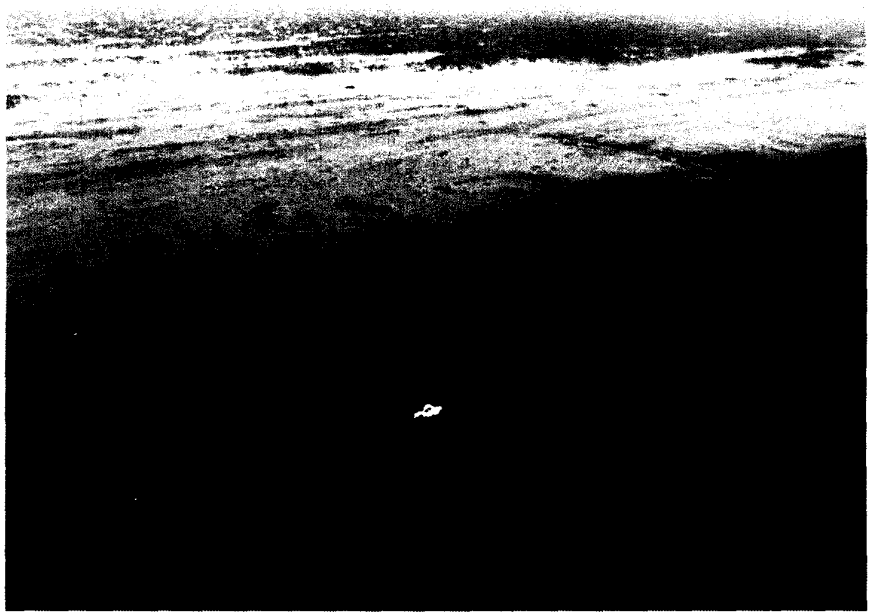
Foulness – Photograph P219 (Ch 2295m)



Foulness – Photograph P220 (Ch 2315m)

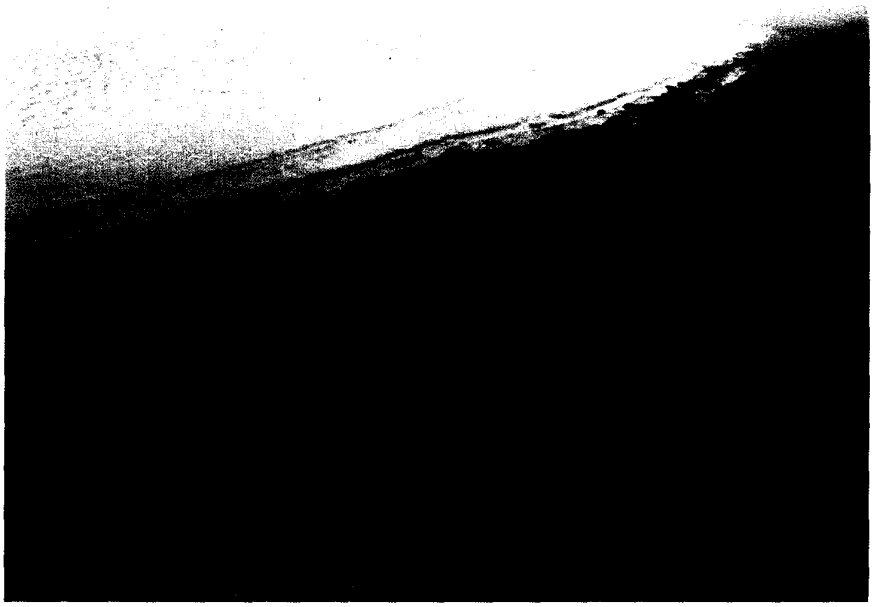


Foulness – Photograph P221 (Ch 2400m)

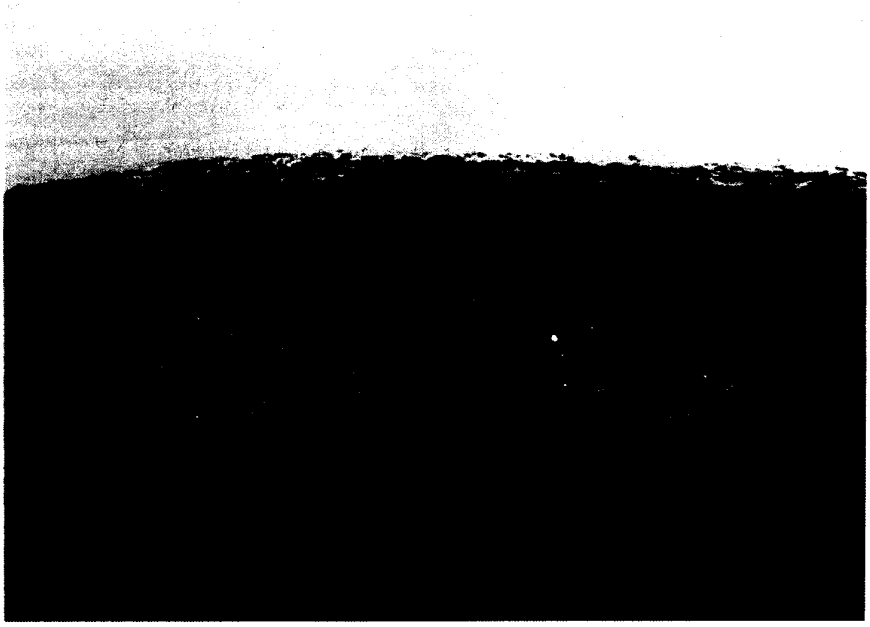


Foulness – Photograph P222 (Ch 2470m)

Foulness – Photograph P223 (Ch 2503m)



Foulness – Photograph P233 (Ch 3177m)

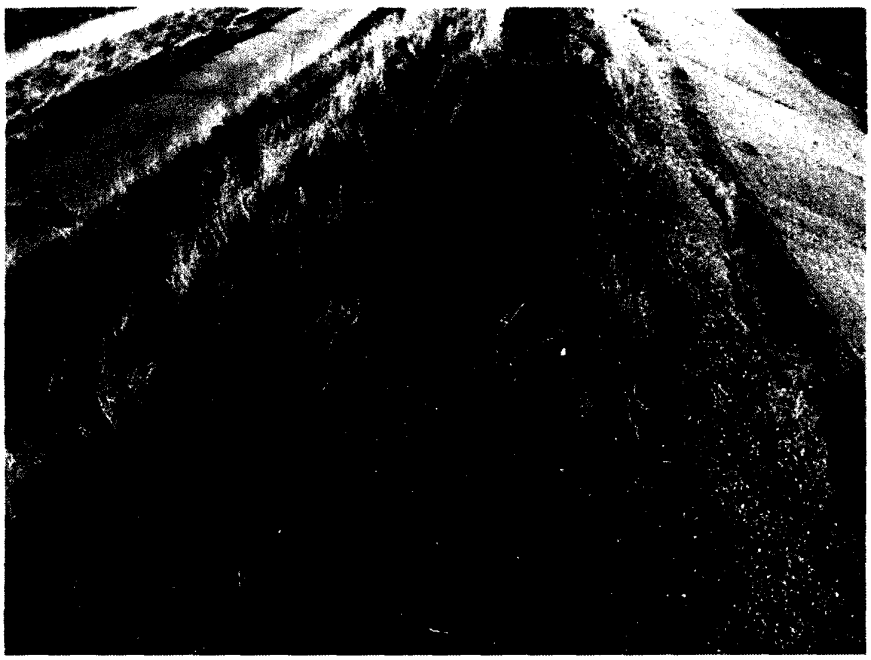


Foulness – Photograph P248 (Ch 4222m)

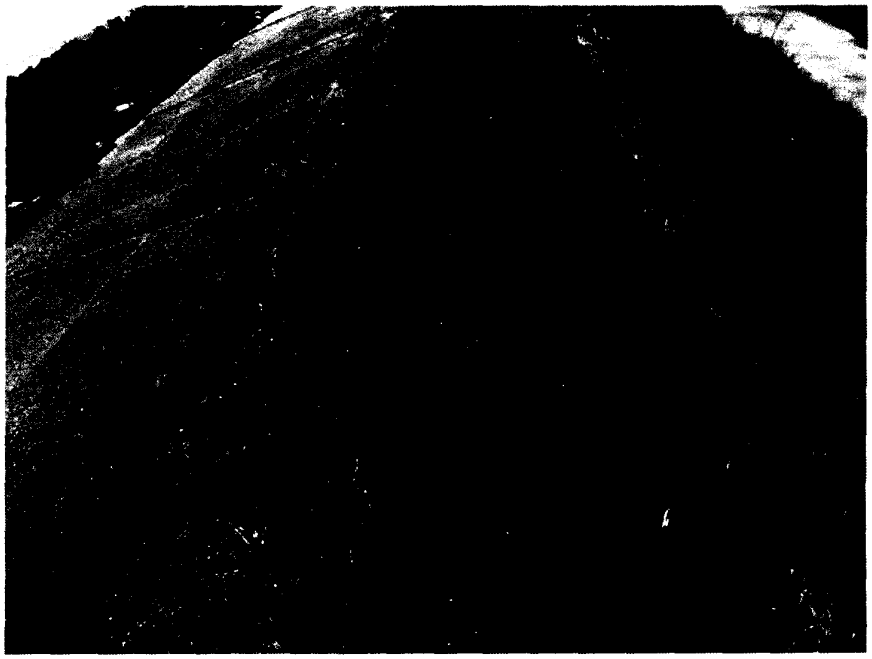
Foulness – Photograph P249 (Ch 4222m)

Foulness – Photograph P764 (Ch 10975m)

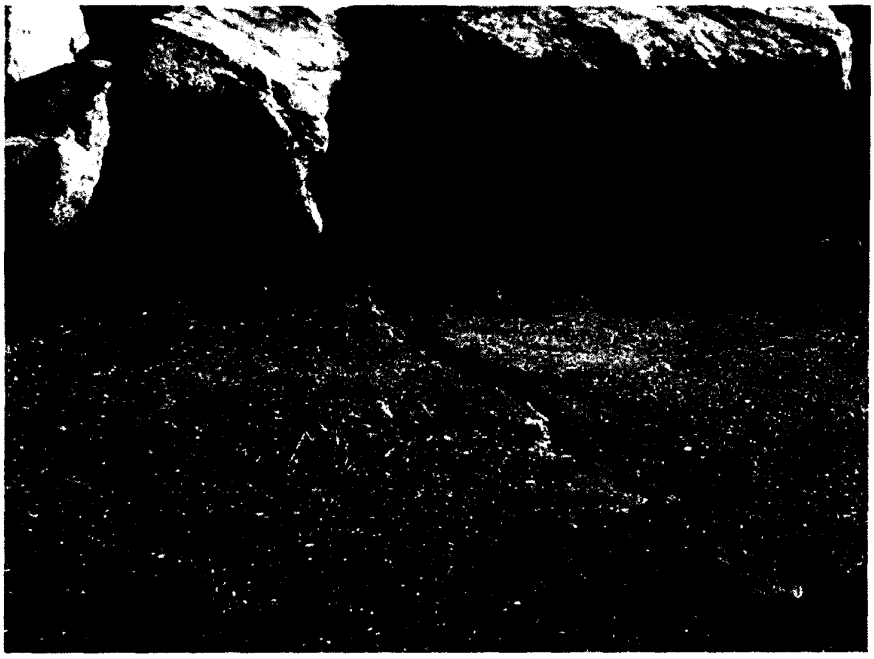
Foulness – Photograph P763 (Ch 10980m)



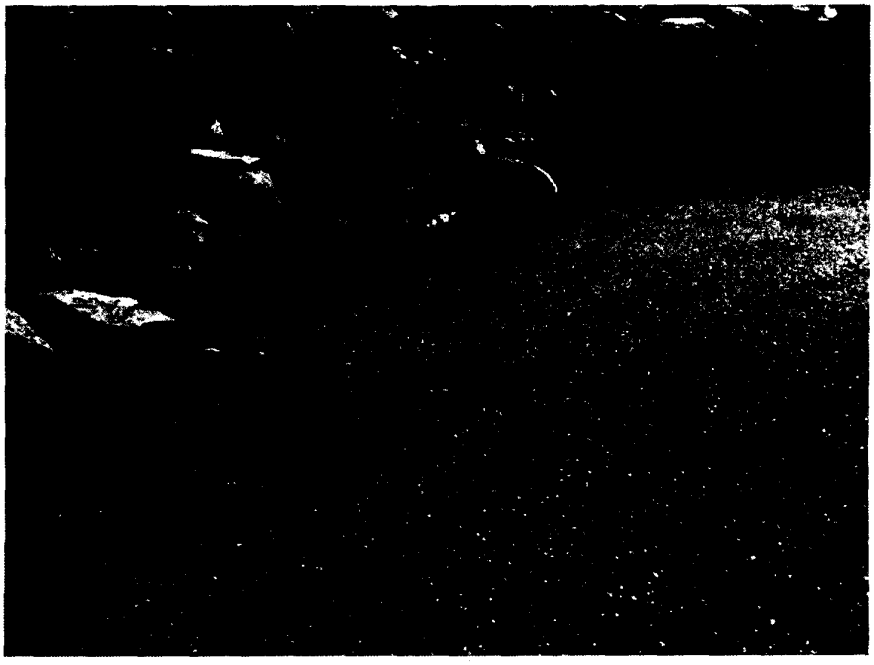
Foulness – Photograph P762 (Ch 11000m)



Foulness – Photograph P765 (Ch 11000m)

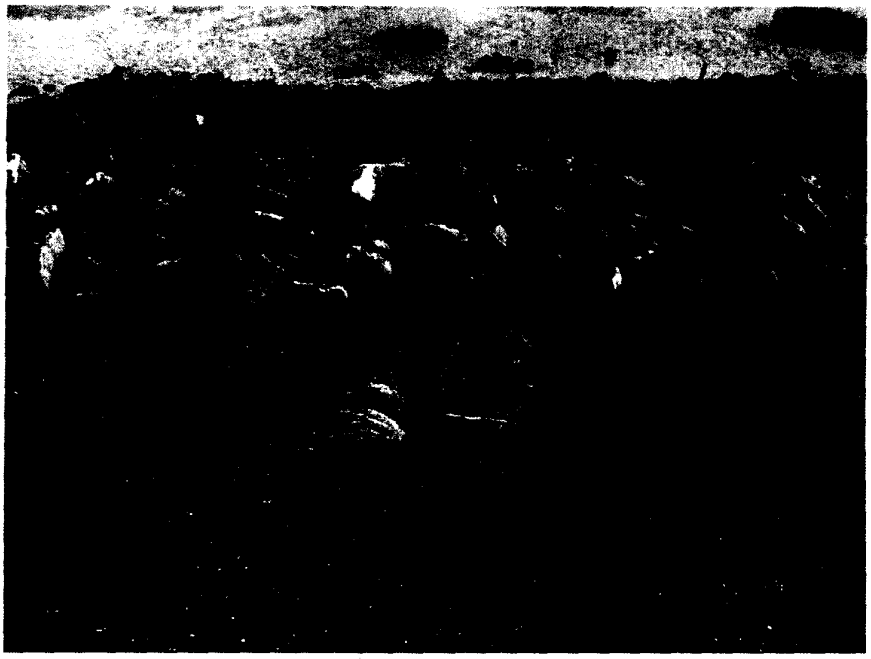


Foulness – Photograph P686 (Ch 16835m)



Foulness – Photograph P685 (Ch 16845m)

Foulness – Photograph P680 (Ch 17050m)



Foulness – Photograph P679 (Ch 17095m)

Foulness – Photograph P678 (Ch 17095m)

Foulness – Photograph P677 (Ch 17115m)

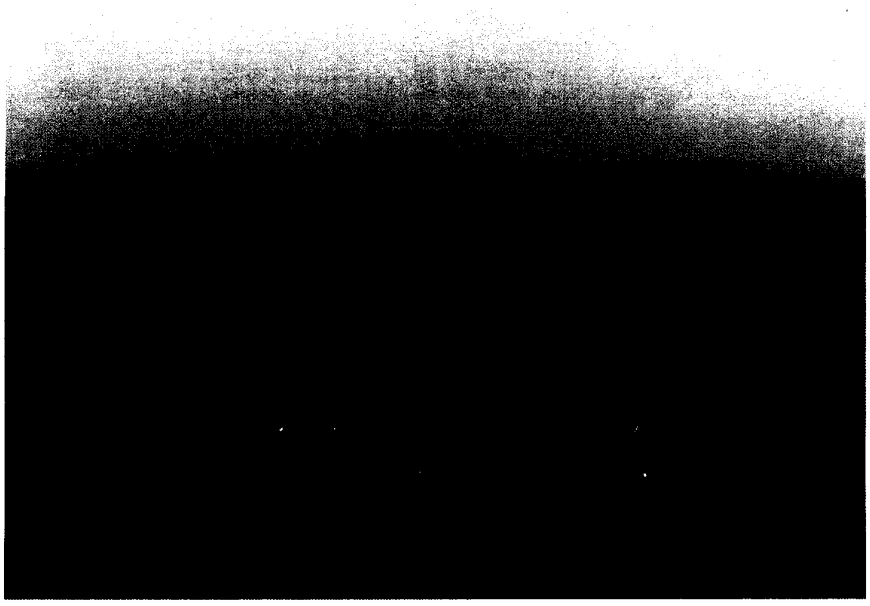
Foulness – Photograph P676 (Ch 17125m)

Foulness – Photograph P603 (Ch 22240m)

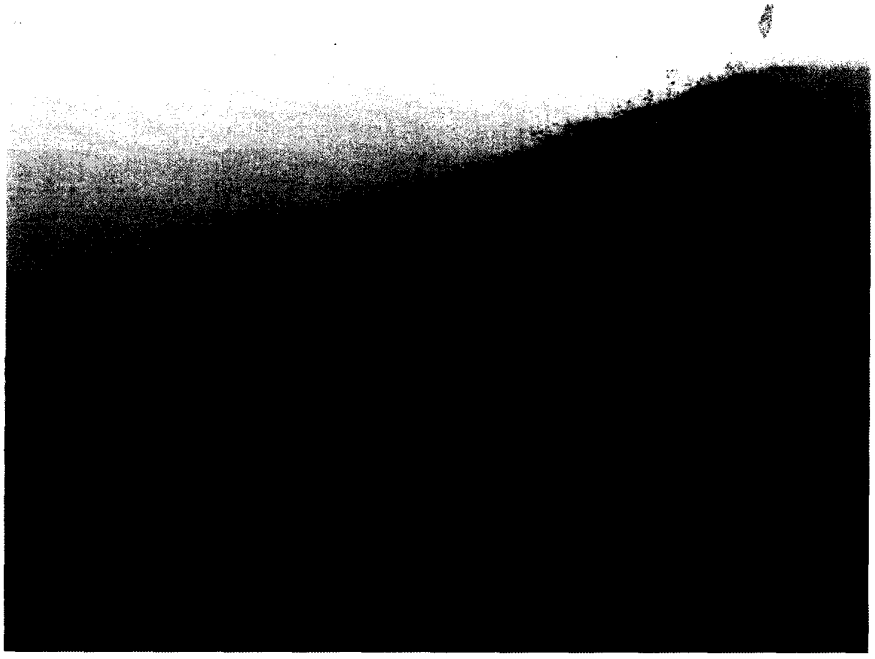
Foulness – Photograph P601 (Ch 22304m)

Foulness – Photograph P578 (Ch 24567m)

Foulness – Photograph P342 (Ch 29115m)

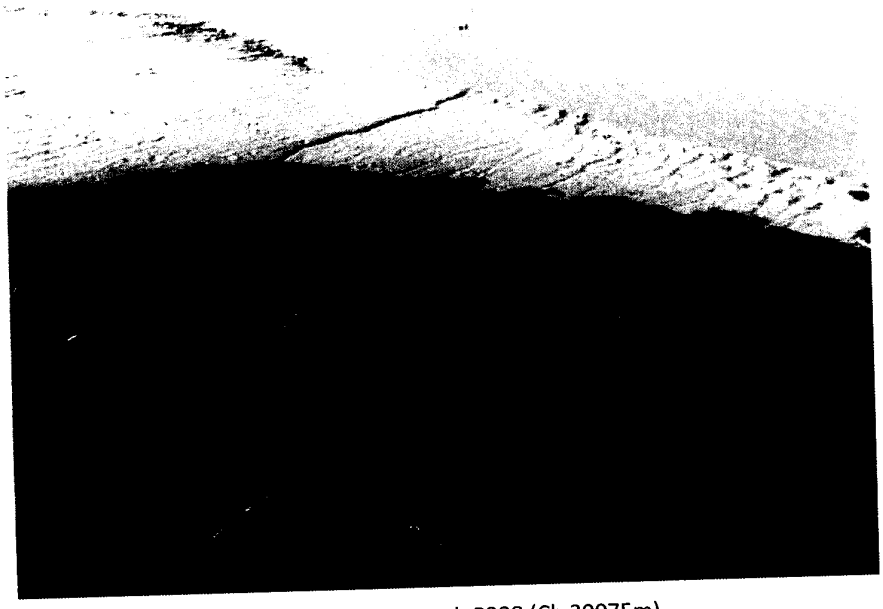


Foulness – Photograph P339 (Ch 29175m)



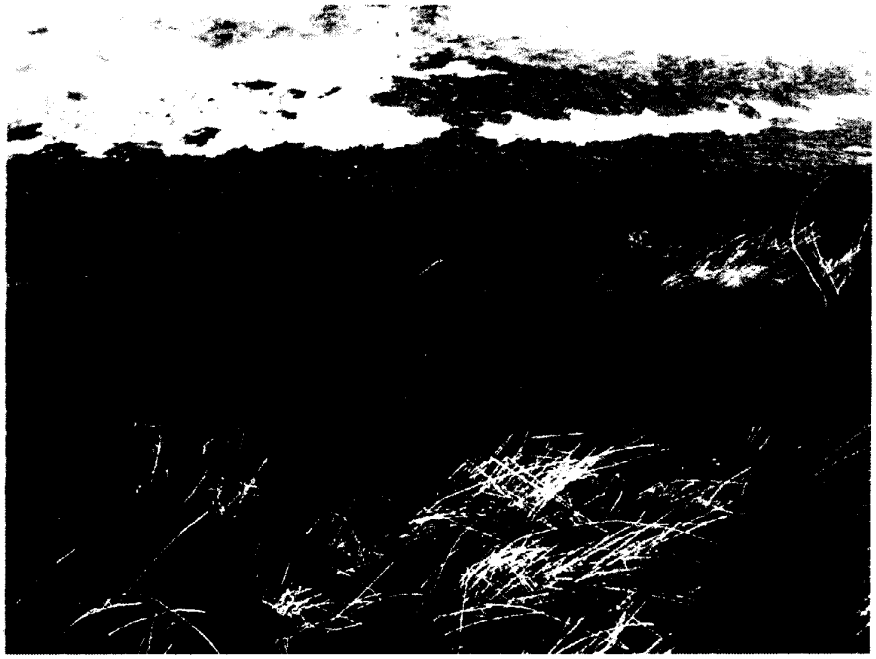
Foulness – Photograph P341 (Ch 29175m)

Foulness – Photograph P329 (Ch 30075m)



Foulness – Photograph P328 (Ch 30075m)

Foulness – Photograph P327 (Ch 30105m)



Foulness – Photograph P326 (Ch 30119m)

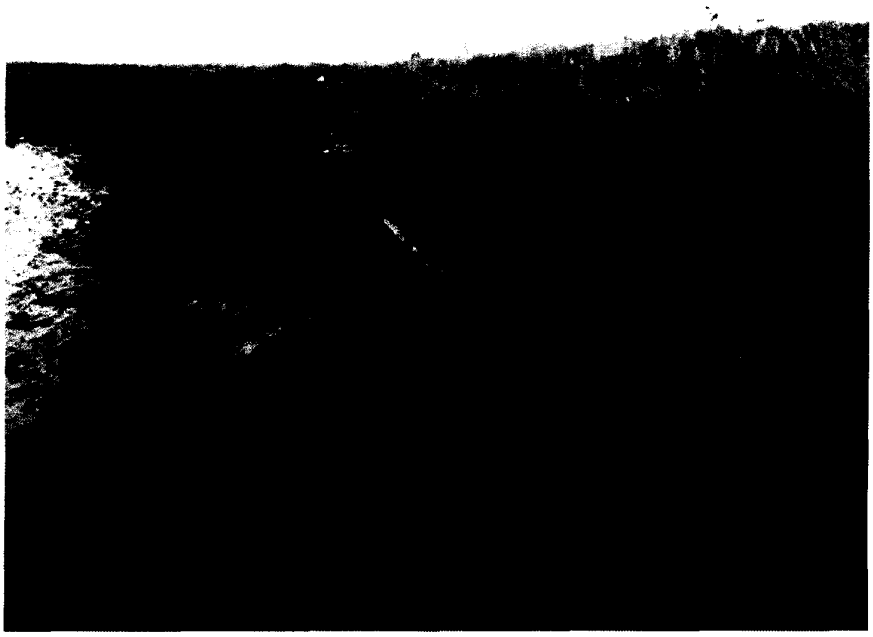
Foulness – Photograph P325 (Ch 30119m)

Foulness – Photograph P316 (Ch 30604m)

Foulness – Photograph P306 (Ch 31156m)

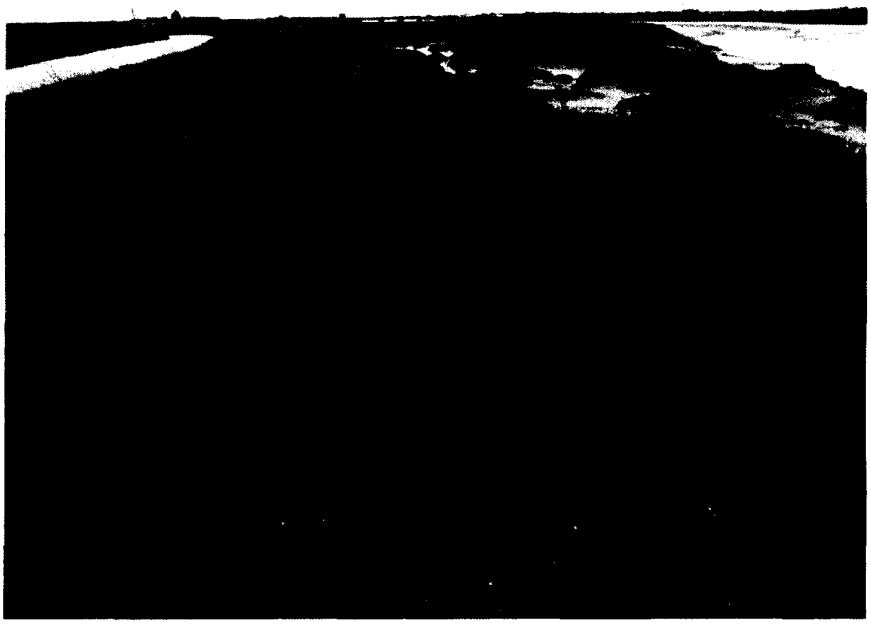
Foulness – Photograph P302 (Ch 31410m)

Potton – Photograph P361 (Ch 15m)



Potton – Photograph P362 (Ch 30m)

Potton – Photograph P363 (Ch 58m)



Potton – Photograph P372 (Ch 760m)

Potton – Photograph P373 (Ch 765m)

Potton – Photograph P374 (Ch 770m)

Potton – Photograph P375 (Ch 790m)

Potton – Photograph P376 (Ch 790m)

Potton – Photograph P377 (Ch 795m)

Potton – Photograph P378 (Ch 795m)

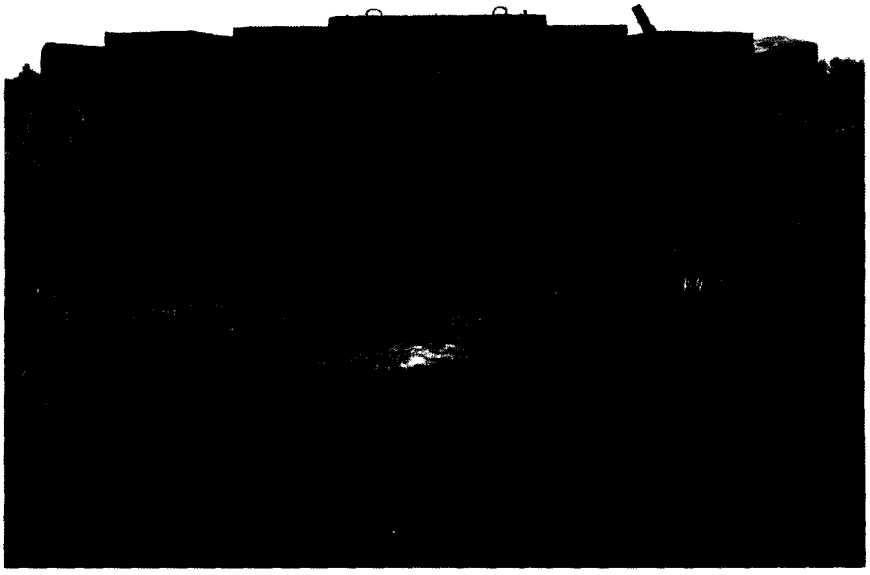
Potton – Photograph P379 (Ch 835m)

Potton – Photograph P380 (Ch 850m)

Potton – Photograph P381 (Ch 854m)

Potton – Photograph P382 (Ch 854m)

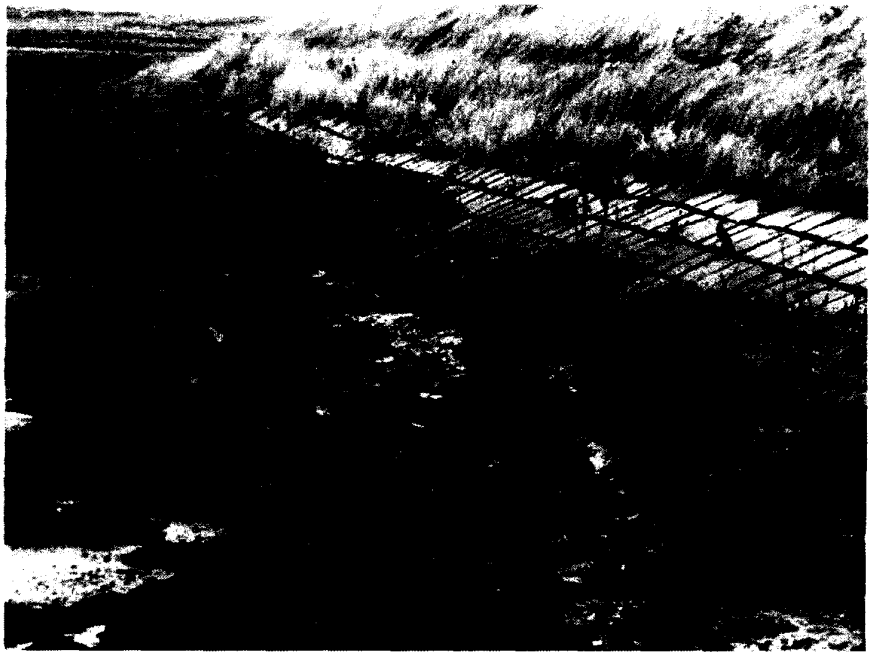
Potton – Photograph P388 (Ch 1125m)



Potton – Photograph P389 (Ch 1131m)

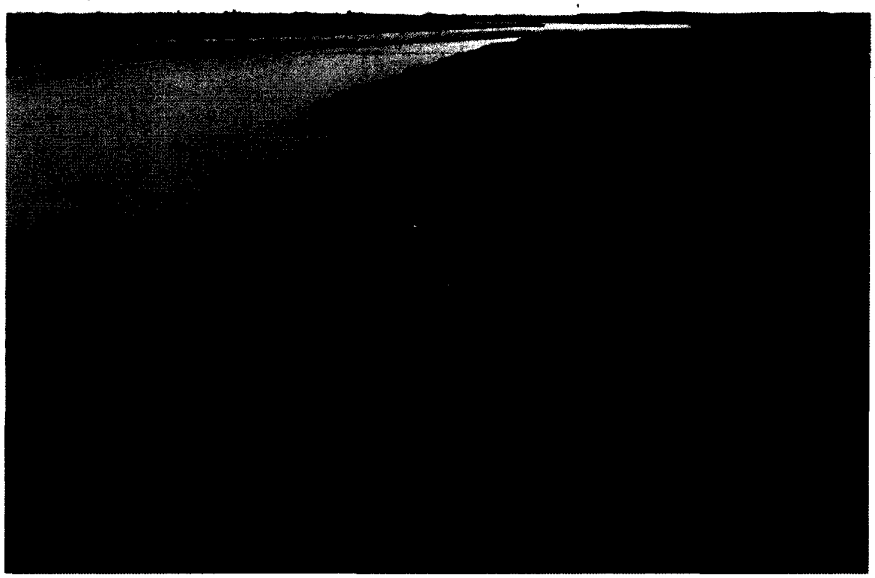
Potton – Photograph P390 (Ch 1131m)

Potton – Photograph P391 (Ch 1150m)



Potton – Photograph P392 (Ch 1150m)

Potton – Photograph P393 (Ch 1185m)

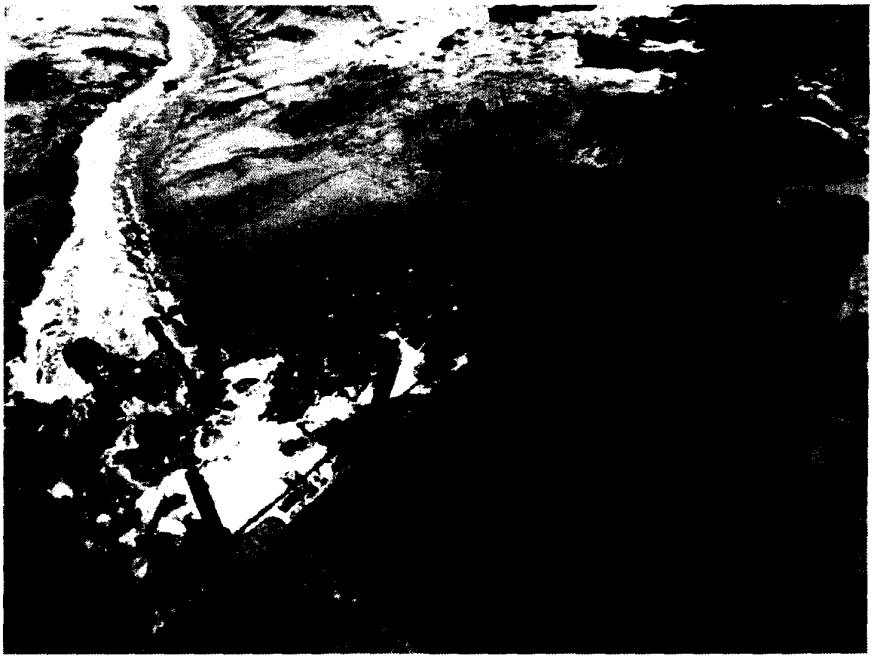


Potton – Photograph P394 (Ch 1185m)

Potton – Photograph P395 (Ch 1190m)

Potton – Photograph P401 (Ch 1865m)

Potton – Photograph P402 (Ch 1870m)



Potton – Photograph P403 (Ch 1865m)

Potton – Photograph P404 (Ch 1870m)

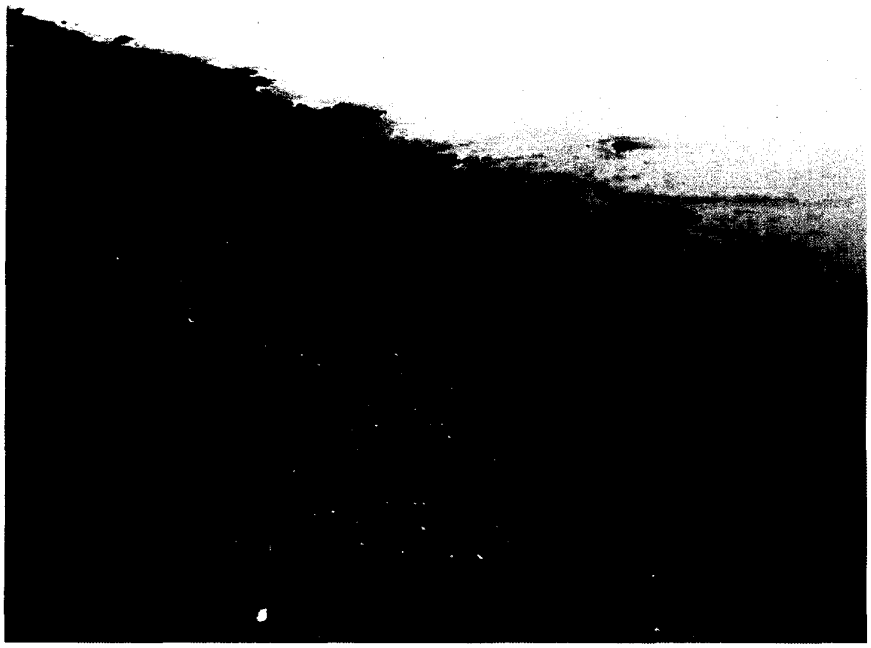
Potton – Photograph P405 (Ch 1885m)

Potton – Photograph P406 (Ch 1885m)

Potton – Photograph P413 (Ch 2325m)

Potton – Photograph P414 (Ch 2325m)

Potton – Photograph P415 (Ch 2325m)

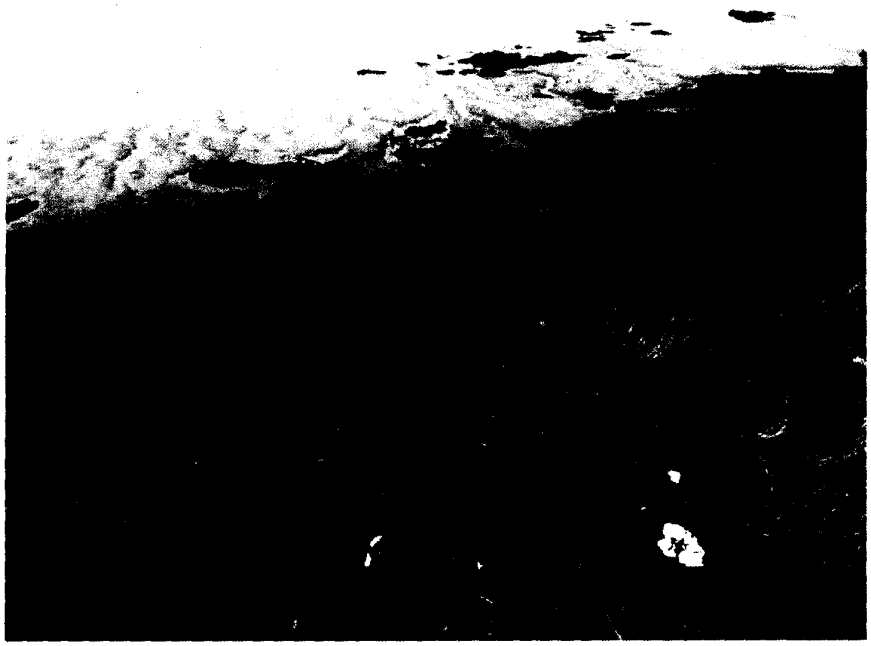


Potton – Photograph P416 (Ch 2350m)

Potton – Photograph P417 (Ch 2436m)

Potton – Photograph P418 (Ch 2436m)

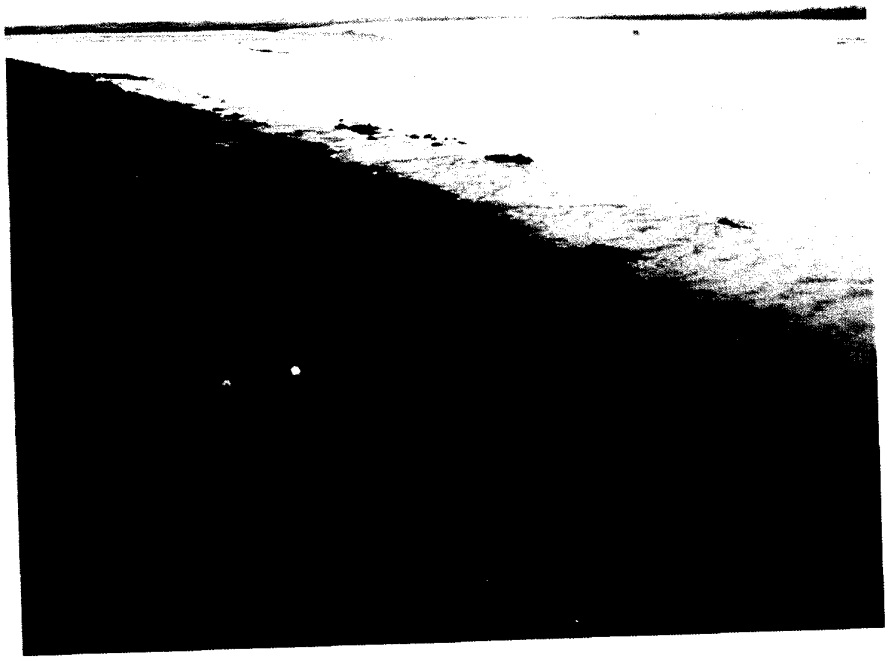
Potton – Photograph P419 (Ch 2445m)



Potton – Photograph P420 (Ch 2445m)

Potton – Photograph P422 (Ch 2460m)

Potton – Photograph P423 (Ch 2480m)

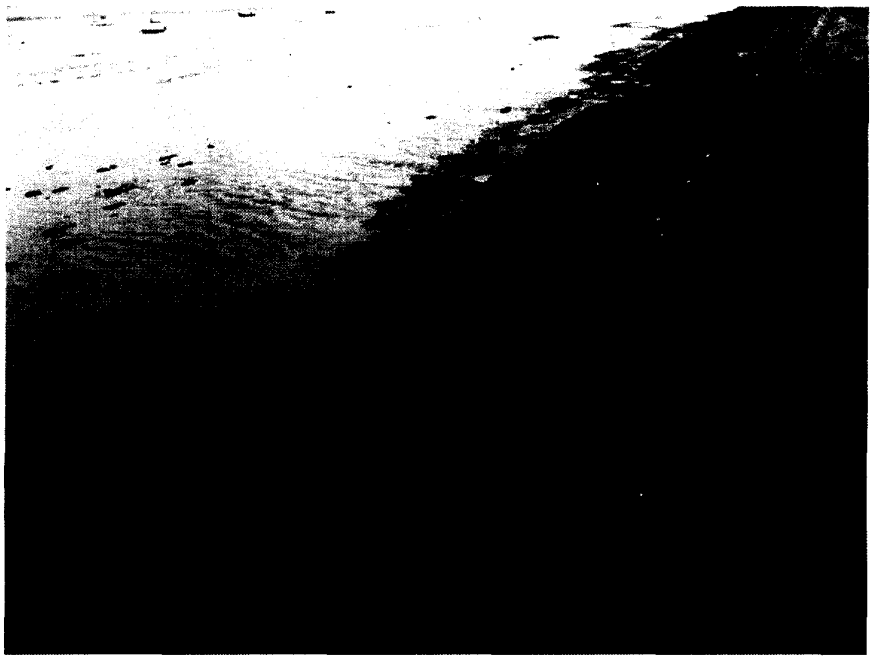


Potton – Photograph P424 (Ch 2490m)

Potton – Photograph P426 (Ch 2560m)

Potton – Photograph P427 (Ch 2560m)

Potton – Photograph P428 (Ch 2570m)

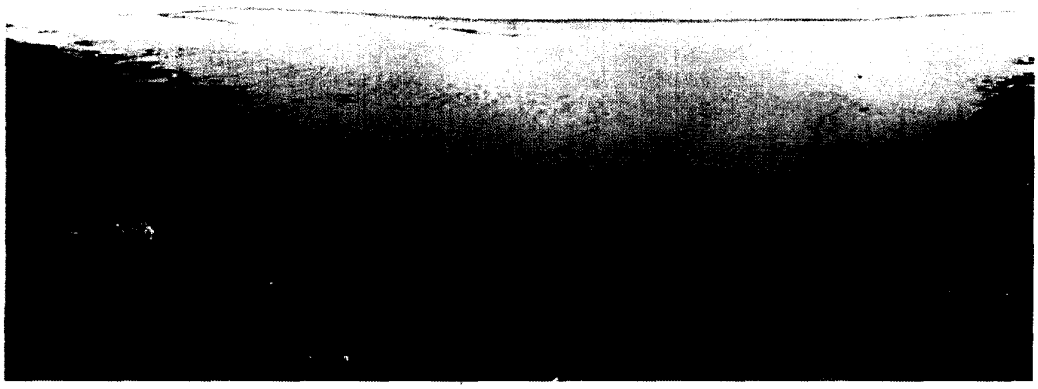


Potton – Photograph P429 (Ch 2585m)

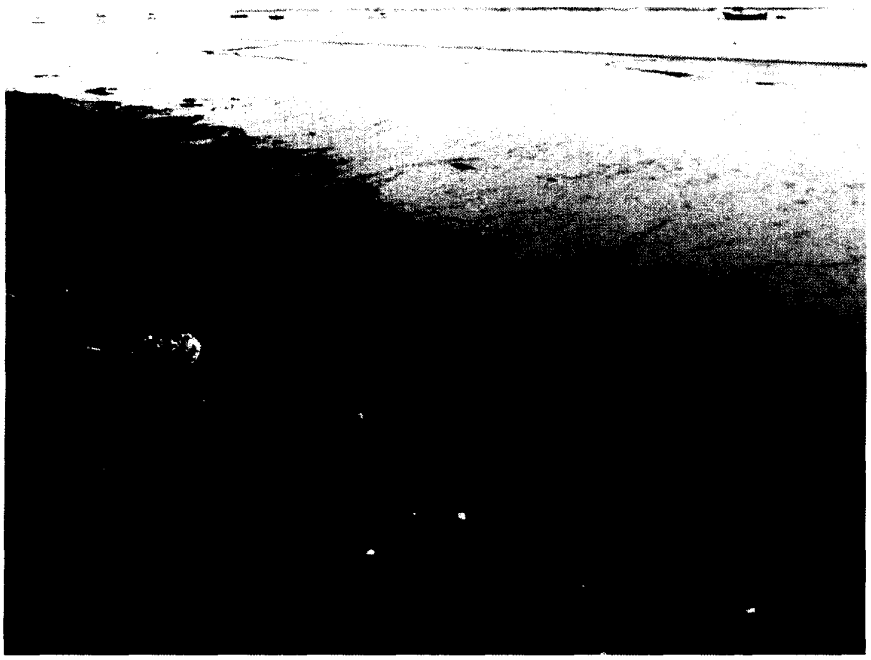
Potton – Photograph P430 (Ch 2595m)

Potton – Photograph P431 (Ch 2598m)

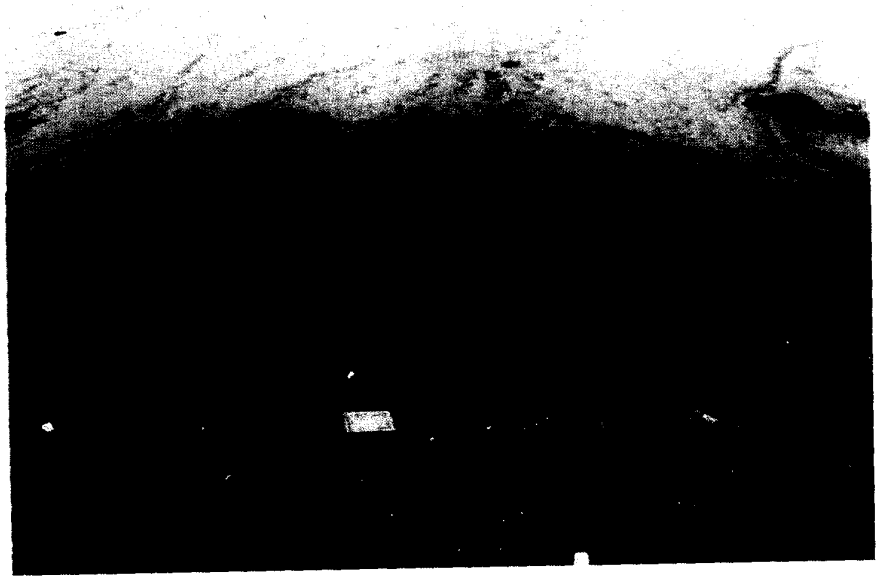
Potton – Photograph P441 (Ch 3002m)



Potton – Photograph P442 (Ch 3015m)

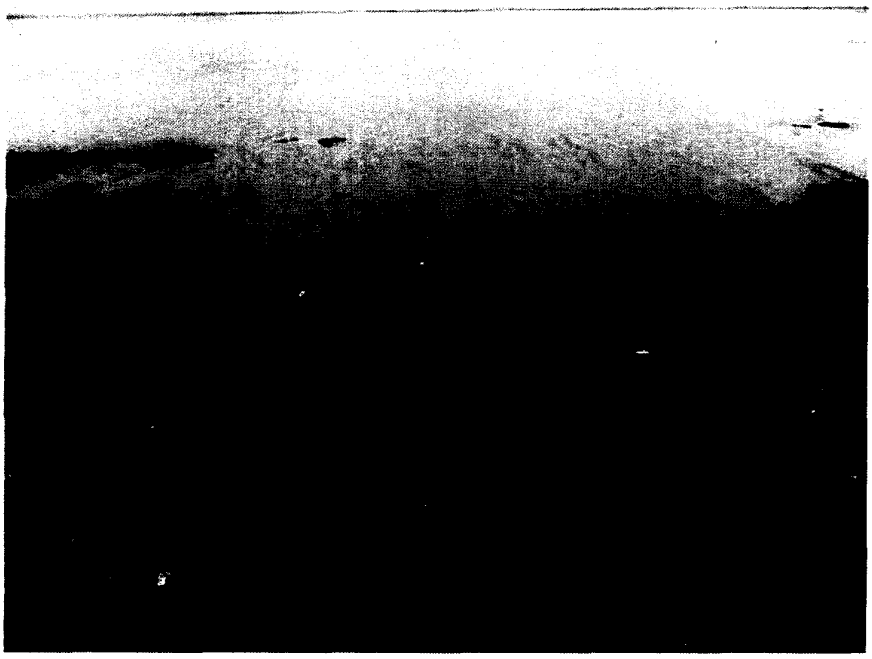


Potton – Photograph P443 (Ch 3025m)



Potton – Photograph P444 (Ch 3025m)

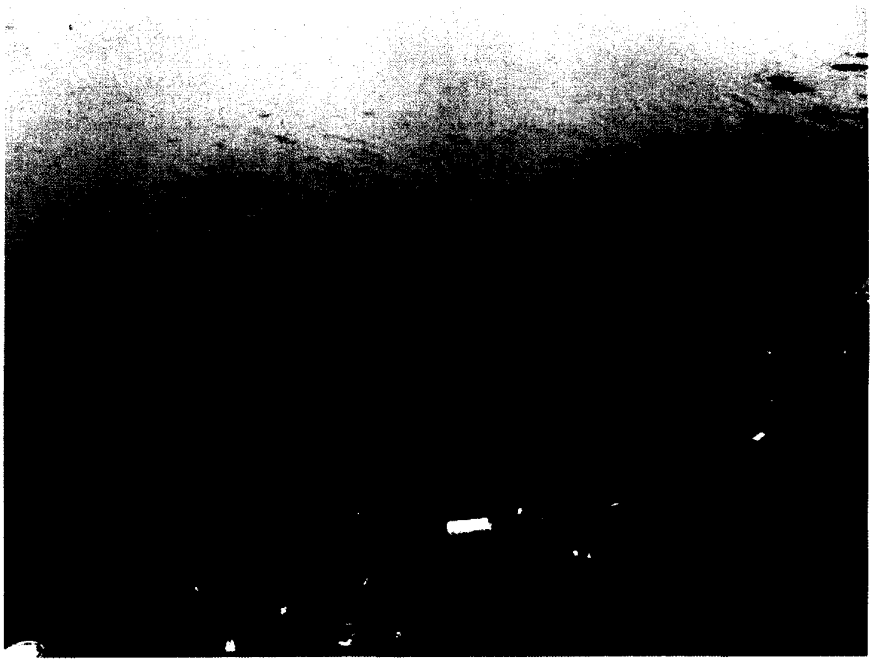
Potton – Photograph P445 (Ch 3025m)



Potton – Photograph P446 (Ch 3095m)

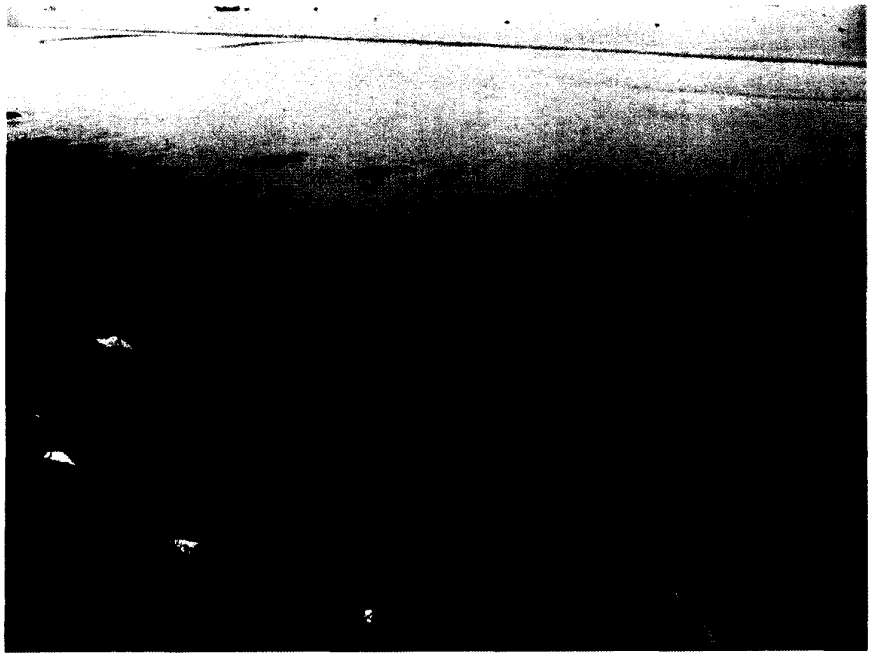
Potton – Photograph P447 (Ch 3095m)

Potton – Photograph P448 (Ch 3134m)

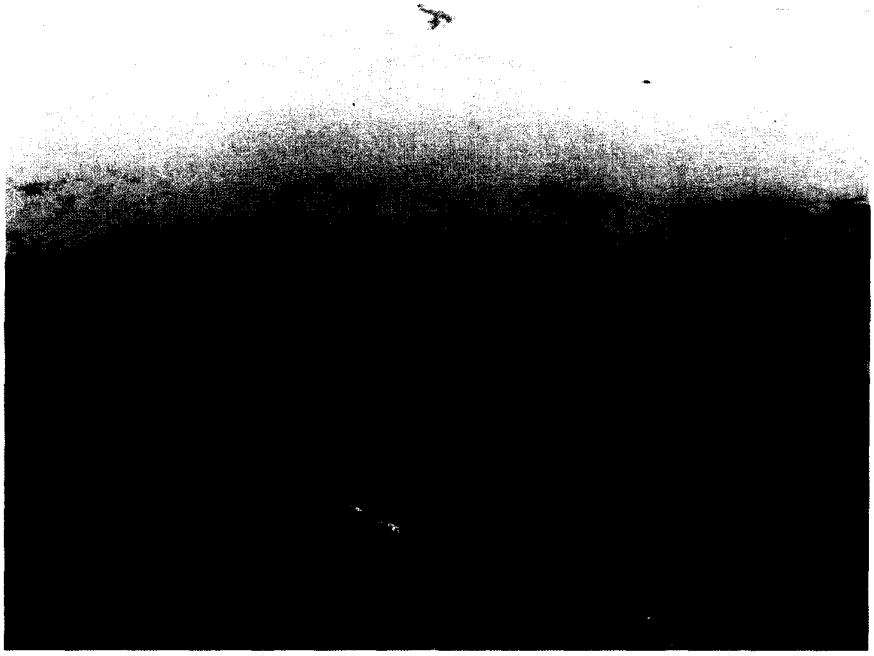


Potton – Photograph P449 (Ch 3140m)

Potton – Photograph P450 (Ch 3150m)

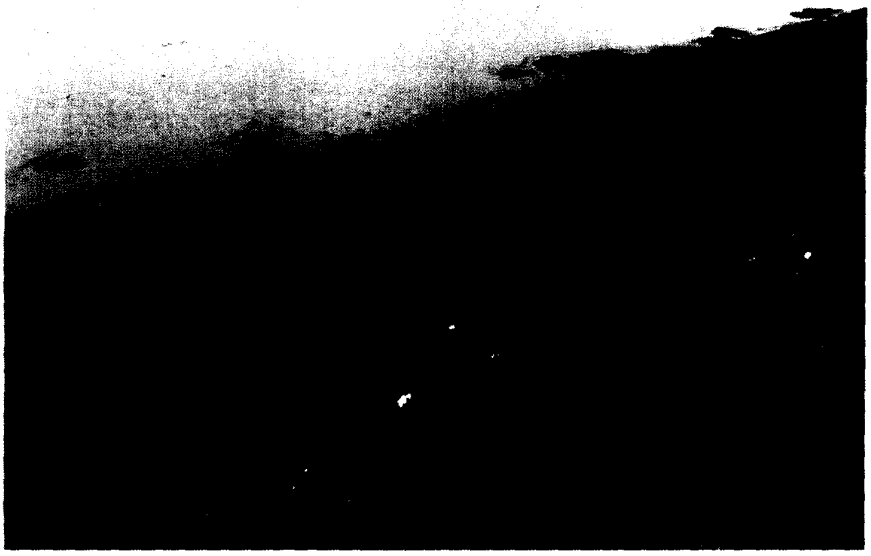


Potton – Photograph P451 (Ch 3181m)



Potton – Photograph P452 (Ch 3181m)

Potton – Photograph P453 (Ch 3181m)

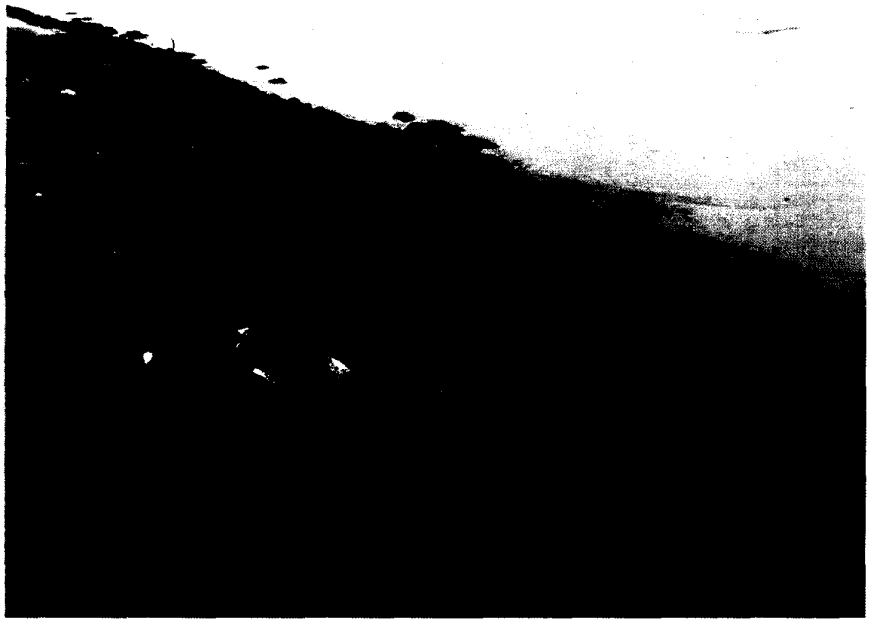


Potton – Photograph P454 (Ch 3210m)

Potton – Photograph P455 (Ch 3225m)

Potton – Photograph P456 (Ch 3230m)

Potton – Photograph P457 (Ch 3230m)



Potton – Photograph P458 (Ch 3240m)

Potton – Photograph P459 (Ch 3240m)

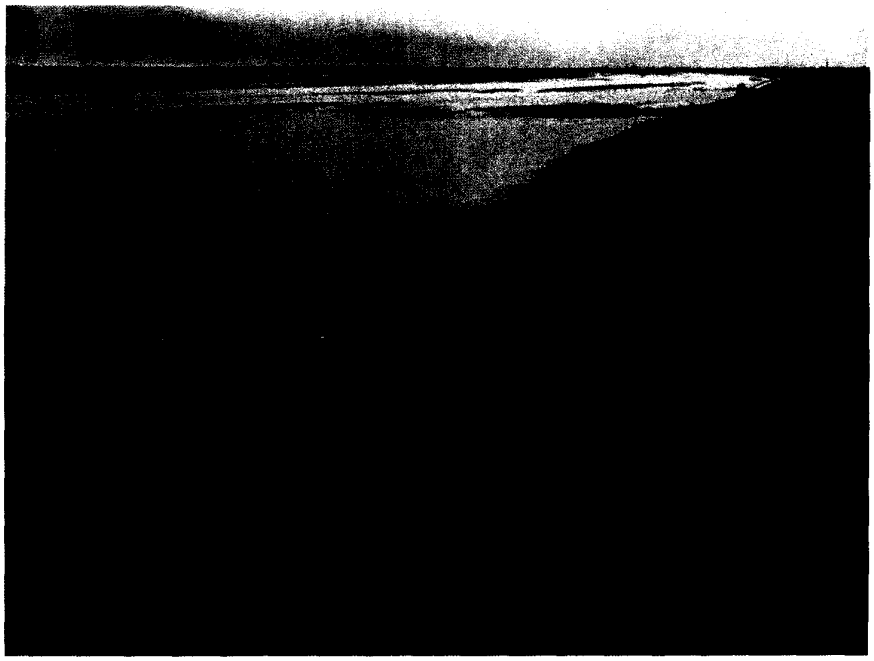
Potton – Photograph P460 (Ch 3260m)

Potton – Photograph P498 (Ch 5895m)

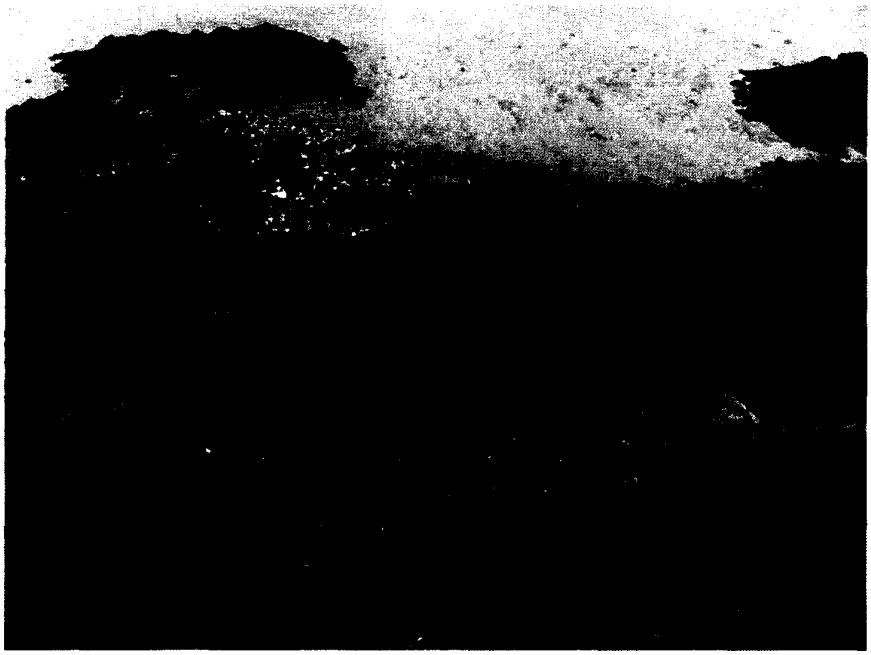
Potton – Photograph P499 (Ch 5915m)

Potton – Photograph P500 (Ch 5915m)

Potton – Photograph P501 (Ch 5915m)



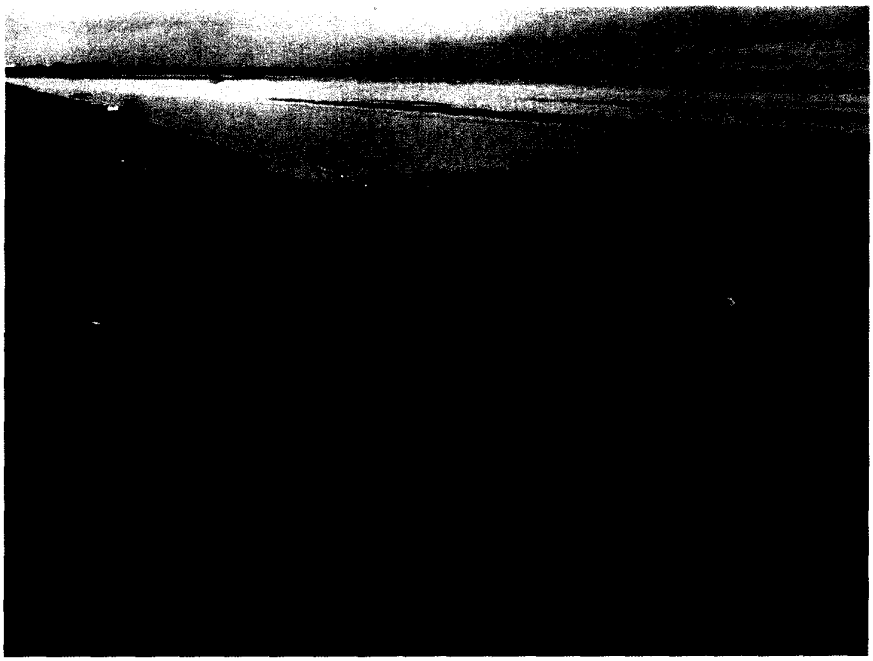
Potton – Photograph P502 (Ch 5935m)



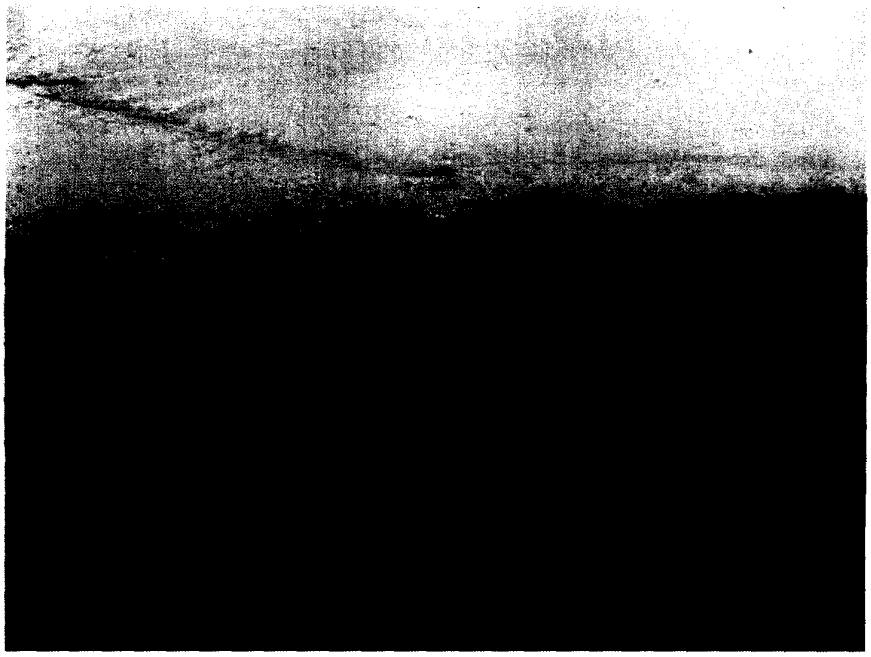
Potton – Photograph P503 (Ch 5950m)

Potton – Photograph P504 (Ch 5965m)

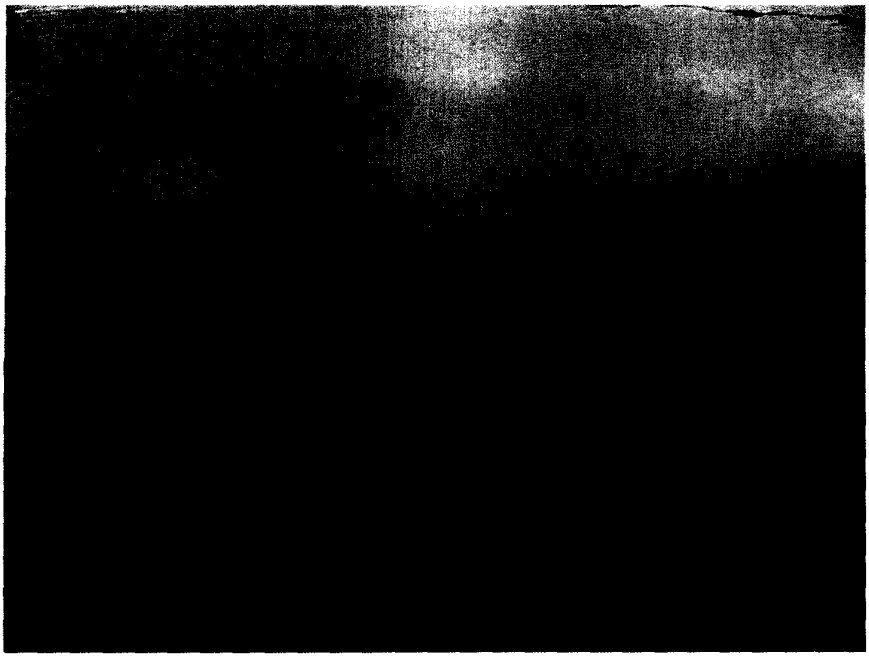
Potton – Photograph P505 (Ch 6010m)



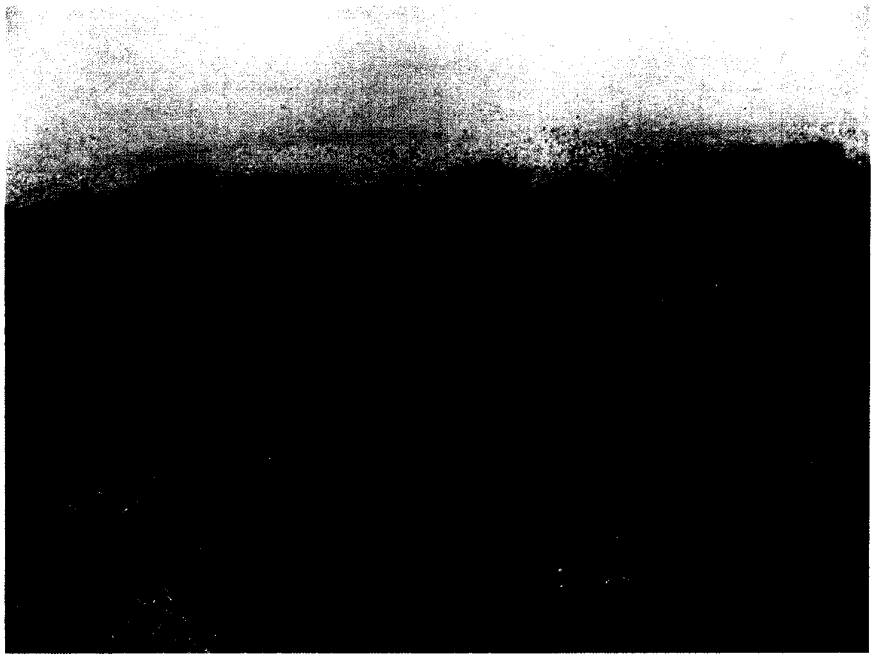
Potton – Photograph 506 (Ch 6060m)



Potton – Photograph P507 (Ch 6065m)



Potton – Photograph P508 (Ch 6065m)



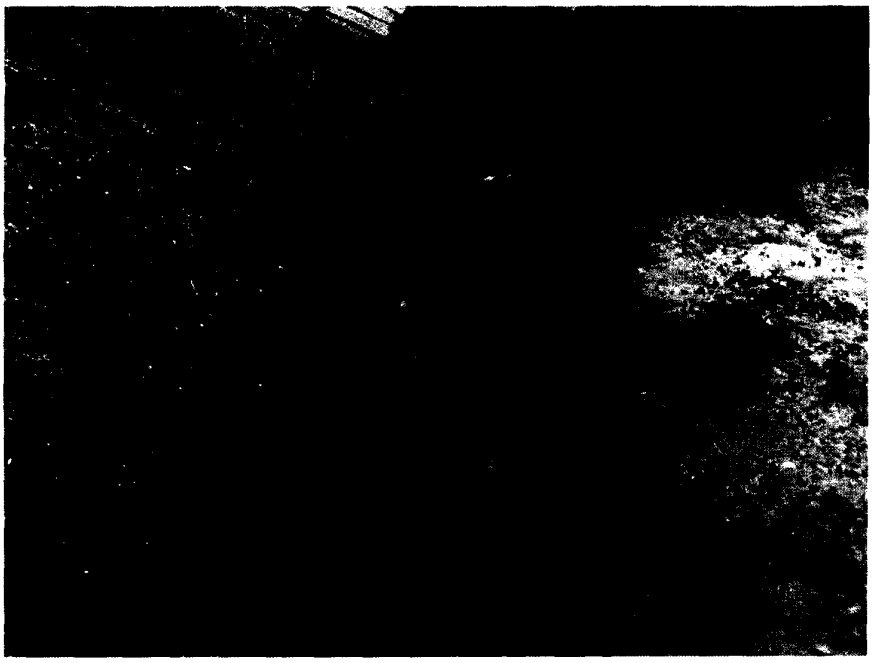
Potton – Photograph P509 (Ch 6075m)

Potton – Photograph P510 (Ch 6075m)

Potton – Photograph P511 (Ch 6090m)

Potton – Photograph P512 (Ch 6100m)

Potton – Photograph P513 (Ch 6110m)



Potton – Photograph P514 (Ch 6110m)

Potton – Photograph P515 (Ch 6115m)

Potton – Photograph P523 (Ch 6990m)

Potton – Photograph P524 (Ch 6990m)

Potton – Photograph P540 (Ch 8195m)

Potton – Photograph P541 (Ch 8195m)

Potton – Photograph P570 (Ch 9130m)

Potton – Photograph P571 (Ch 9135m)

Potton – Photograph P572 (Ch 9145m)

Potton – Photograph P573 (Ch 9150m)

Potton – Photograph P574 (Ch 9155m)

Shoeburyness – Photograph P076 (Ch 540m)

Shoeburyness – Photograph P083 (Ch 850m)